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ABSTRACT

This teacher's manual is the approved provincial guide for grade 10 science in Manitoba schools. Part 1 (an overview) discusses rationale, learning theory/design, and goals/objectives for the curriculum; design of Science 100 and 101; effects of metric system on the curriculum; special needs students; and student evaluation. Part 2 discusses implementation of the program focusing on curriculum materials, instructional options, alternative approaches to implementation, implementation costs, small schools, role of the guide and support materials, laboratory equipment, and implementation procedures. The next two parts focus on the subject matter of Science 100 and Science 101 respectively. Rationale, basic/supplementary references, and a table of objectives correlated with suggested activities and references are provided for each content area. Design for both Science 100 and 101 includes a "core" or prescribed section and an optional section, providing for flexibility in terms of choice among optional units, teaching approaches, and teaching materials. Sources of curriculum materials used include "Introductory Physical Science (IPS)," "Physical Science: An Introductory Study (PSIS)," "Individualized Science Instructional System (ISIS)," and "Interaction of Matter and Energy (IME)." A brief description of these materials and a list of process skills fostered in the curriculum are included in appendices. (JN)

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science 100, 101

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1982

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This guide replaces the Physical Science 101 guide (1971) and the revised interim version issued in 1981. It has been developed as part of an overall revision of science programs for Manitoba schools and is designed to articulate with the proposed guides for grades 11 and 12. The pilot guide was tested in some Manitoba schools during 1979-80 and has been revised on the basis of feedback obtained from teachers and students. Science 100, 101 (1982) becomes the approved provincial guide for science in grade 10, effective September, 1982.

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Brian Burdy	St. John's High School, Winnipeg School Division #1	John Fast	Fort Richmond Collegiate, Fort Garry School Division #5
Dave Cochrane	Neepawa Area Collegiate, Beautiful Plains School Division #31	Gerry Neufeld	Faculty of Education, Brandon University
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William Soprovich	Curriculum Development Branch, Department of Education	Evhan Uzwyshyn	Curriculum Services Branch, Department of Education

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SCIENCE 100

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E. Doell	W.C. Miller Collegiate
A. Fontaine	Ste. Rose Collegiate
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W. Watts	Grant Park High School

SCIENCE 101

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overview

RATIONALE

"A general education in the sciences should make it possible for people to appreciate the worthiness of the scientific enterprise and to use its achievements for attacking contemporary problems, as well as designing the future we seek."[1]

During the 1960's, science and technology were perceived to hold the promise of a bright and expanding future for mankind. But with the arrival of the 1970's this perception was modified. While advances in nuclear technology provided an additional source of energy, disposal of nuclear wastes created a serious new problem; and while the development of organic pesticides saved millions of lives, their use created imbalances within some ecological systems. Increasingly, the application of modern, scientific knowledge to life has been recognized as having both positive and negative effects.

To live successfully in the changing environment, the individual needs to understand how it is influenced by the impact of scientific and techno-

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[1] Paul DeHart Hurd, "Scientific Enlightenment for an Age of Science," The Science Teacher, 46 (January 1979), p 15.

logial developments. The individual needs to understand that even though scientific knowledge has improved certain areas of life--by developing new energy sources, consumer goods and disease control mechanisms, for instance--it cannot be relied upon to solve all individual and societal problems.

The science curriculum should provide students with opportunities to examine ways in which humankind have explored, used and altered the environment, as well as ways in which changes in the environment have taken place naturally. It should provide them with opportunities to make practical applications of scientific principles in order to realize the limitations of and the trade-offs associated with these applications. And because students today are bombarded with an increasing amount of conflicting information from a variety of sources, the curriculum should provide them with opportunities to develop the analytical and organizational skills that enable them to reach intelligent conclusions. They should learn to select and order data, control and eliminate irrelevant variables, weigh scientific evidence, and draw conclusions. By providing a variety of experiences, the science program should foster in students open-mindedness, respect for accuracy, and the ability to form opinions based on adequate evidence.

The Science 100 program is designed to help students achieve the above goals by providing them with opportunities to gather and interpet data both in a scientific/technological context and in the area of educated opinion. For example, to determine whether seat belt laws should be enforced, students should not only consider the scientific evidence about the effectiveness of seat belts during collision, but also the human values related to this issue.

Another role of the Science 100 program is to provide students with opportunities to continue developing skills and acquiring knowledge that will be useful to them in further science studies. A survey of Science 200 teachers indicates that in addition to general scientific knowledge, the development of certain mathematical and process skills are important. (These skills are defined within the objectives contained in this guide.) Since processes are developed continuously and represent one of the goals of junior high science, the Science 100 program should, in this respect, be considered a part of the total science program in grades 7-10.

Similar to Science 100, Science 101 is designed to help students understand both basic science and the impact of science and technology on society and the individual. In addition, the course should enable students to develop the scientific processes that can be used to resolve science-related problems and issues. Problem-solving may involve the application of scientific knowledge; for example, knowledge of the basic principles

of combustion can be applied to explain fire control or to develop safety procedures. Or, the resolution of a problem may involve the interpretation of data and the formulation of hypotheses; for example, a comparison of data on the availability of fossil fuel reserves with data on the rate at which fuels are used can be made to help resolve hypotheses concerning the need to conserve energy or to develop alternate energy sources.

LEARNING THEORY AND DESIGN OF SCIENCE 100, 101

Both the Science 100 and 101 programs attempt to take into account the intellectual and social development of young adolescents. Research indicates that most 15- to 16-year-old students are in transition from a concrete to a formal stage of intellectual development. Students in the concrete stage can solve problems through the manipulation and observation of concrete objects, examples or situations, but they tend to concentrate on one factor alone while ignoring other equally relevant ones. Students in the formal stage can solve problems by manipulating words or symbols, isolating or controlling variables, and effectively using hypothetical-deductive reasoning. As research indicates, whether a student's response to a problem is formal or concrete depends upon the specific context of the problem and the student's background knowledge (e.g., concepts, familiarity with possible variables).

The Science 100 program, which generally includes students with a wide variety of abilities, attempts to provide for variation in cognitive levels and motivation by advocating an activity-based approach, by developing material from concrete to abstract, and by presenting materials and activities that reach various levels.

The Science 101 course also emphasizes an activity-based approach but assumes that 01 students' interest in science is less well developed than that of 00 students. It also attempts to provide for a variety of interests and abilities by recommending

an individualized approach, by using more concrete and less abstract materials, and by emphasizing the practical.

It should be remembered that the basic goals of Science 100 and 101 are similar. Young adolescents need to understand themselves in relation to their peers and to their society. Both Science 100 and 101 attempt to provide students with some background upon which to base their understanding of human development and of the relationship between science and the practical world.

GOALS AND OBJECTIVES OF THE SCIENCE 100, 101 PROGRAM

In general, the goals for science education in the high school are similar for all science courses. The emphasis placed on certain goals can vary, however, depending on student ability, interest, and concern for post-secondary careers, as well as on certain other conditions. In general terms, therefore, the goals of Science 100, 101 are similar to those of other high school science courses, the differences only becoming apparent when the goals are broken down into objectives. The intent of a general goal--for example, "To aid the student in understanding the impact of science and technology upon the human and natural environment"--can be understood more exactly when stated in relation to a specific topic, as these objectives that appear in the unit "Motion and Collisions" exemplify:

- Compare the injuries of belted and unbelted passengers in graphs or tables.
- Describe when seat belts work best to reduce injuries to passengers in collisions.
- Use vectors to calculate the resultant force on a car traveling around a curve.

Goals for Science 100, 101 are broken down into objectives later in this section, and appear again under the column of objectives in the unit design charts ("Science 100" and "Science 101"). Since these objectives specifically state the intent of each unit, they should assist teachers both in planning potential activities and in evaluating completed activities.

Differences Between Science 100 and Science 101

Early in the design of the Science 100, questionnaires and teacher interviews were used to determine teacher perception of the need for developing certain skills and knowledge in those students intending to continue with "00" courses. Essentially, teachers indicated that the most critical goal for Science 100 was to develop student skills in scientific processes and basic mathematics. While this goal is important for both Science 100 and 101, the 100 level course places more emphasis on the quantitative and problem-solving aspects of science. For example, unlike 101 students, students of Science 100 are expected to be able to calculate the volume or mass of a solid, liquid or gas using the density formula. As in Science 100 and 101, later 00 and 01 courses continue to develop this goal with different emphases.

The goal which emphasizes the impact of science and technology on humans is considered to be important in all high school science programs, and hence it is developed in both Science 100 and 101. It receives more emphasis at the 101 level, however, given that the problem-solving aspect of science takes precedence at the 100 level. But when similar units developing this goal appear in both courses, it should be recognized that more advanced objectives are introduced at the 100 level. For example, both Science 100 and 101 explore the impact of science and technology on humankind in similar units called "Cells," but Science 100 includes additional objectives such as the one following: "Describe the process of DNA replication and its importance to cell division."

Whenever Science 100 and 101 address the same topic a
share common basic objectives, the provision of addit
al objectives in Science 100 allows for the developme
of increased complexity within this course.

Therefore, although Science 100 and 101 share the sam
goals and a certain of the same objectives, the two
cou:es are different in the amount of rigor that is
possible within them. In the time available, teacher
of Science 100 can develop some fundamental scientifi
concepts--concepts supportive of later science educa-
tion--more fully than can teachers of 101; teachers o
Science 100, consequently, can expect a more advanced
level of understanding from their students.

GOALS FOR SCIENCE 100 AND 101

The goals of the Science 100 and Science 101 courses

1. To aid the student in developing the process skil
   and attitudes necessary for inquiring systematica
   into questions about the natural world. The impo
   tant science process skills include:[1]

   a. Observing - using all the senses,
   b. Classifying - grouping related objects or ide
   c. Quantifying - using numbers and measurements,
   d. Formulating hypotheses,
   e. Making operational definitions,
   f. Controlling and manipulating variables,
   g. Interpreting data and results,
   h. Formulating models,

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[1] These skills are further defined, and examples give
in Appendix A.

i. Communicating - using such means as discussion, tabulation, graphs,
j. Inferring,
k. Predicting,
l. Experimenting - planning and designing an investigation.

2. To aid the student in preparing for future science courses by providing content knowledge in physical and biological sciences.

3. To aid the student in self-awareness and in understanding the environment and the interrelationships that exist within the environment.

4. To aid the student in understanding the impact of science and technology upon the human and natural environment.

5. To develop the student's interest in and appreciation of scientific values and problem-solving and to promote attitudes of curiosity and open-mindedness; respect for accuracy, precision, and opinions based on adequate evidence; and belief in cause-effect relationships.

6. To train students in safe laboratory practices such as proper care of equipment, correct experimental procedures, and appropriate work habits.

7. To foster positive attitudes towards science.

SCIENCE 100 OBJECTIVES

Following are the objectives for Science 100.

Measurement and Experimentation (compulsory)

The student should be able to:

- Discuss the meaning of the following terms in relation to an experiment:
  . variable,
  . experimental control,
  . hypothesis,
  . generalization,
  . model.

- Identify and use the common SI units for length, area, volume and mass (using only the prefixes milli-, centi- and kilo-), and perform the following measurement activities:
  . Use a balance correctly;
  . Use a metric ruler to determine the dimensions of regular solids;
  . Read a graduate;
  . Calculate the volume of a regular solid;
  . Determine the volume of an irregular solid by water displacement.

Characteristics of Matter (compulsory)

The student should be able to:

- Recognize that every measurement involves

some uncertainty.

- Calculate the densities of solids, liquids and gases.

- Calculate the volume or mass of a solid, liquid, or gas, using the density formula.

- Describe the differences in the properties of solids, liquids, and gases.

- Describe the three states of matter and the factors affecting the changes in state:
  . Describe mass, temperature, volume and density changes with a change in state;
  . Determine the freezing point (melting point) of a substance;
  . Determine the boiling point of a liquid;
  . Recognize the variables that determine the length of a plateau in a heating or cooling curve;
  . Describe the relationship between pressure and the boiling point of a liquid;
  . Describe the effect of adding solutes on the freezing and boiling point of liquids;
  . Describe the process of sublimation.

- Use a simple particle model of matter to describe the spatial differences between the molecules making up solids, liquids and gases.

Separation of Substances (compulsory)

The student should be able to:

- Recognize the unique properties and the importance of water.
- Describe the composition of water.
- Determine the water content of certain substances.
- Describe the characteristic properties of solutions.
- Determine and describe the effect of temperature, the nature of the solute, and the nature of the solvent on the solubility of a solid.
- Describe characteristics of suspensions, emulsions, and colloidal dispersions.
- Differentiate between mixtures and pure substances.
- Utilize various techniques to separate various mixtures.
- Describe how a mixture of gases can be separated.
- Relate how petroleum is formed and separated into components.

Fossil Fuels (required option)

The student should be able to:

- Describe how fossil fuels may have been formed and why the supply is limited.

- . Describe how recent trends in North America's use of fossil fuels compare with trends in world use;
  . Identify the most abundant and least abundant fossil fuels.

- Describe the pros and cons of using coal rather than oil or natural gas in terms or availability, environmental effects, and efficiency.

- Describe the environmental effects of extracting and transporting fossil fuels.

- Describe how pollutants from car exhausts can be reduced by catalytic converters.

- Describe how energy can be converted from one form to another and show how energy is conserved in the process; describe how useful energy may be lost during conversion.

- Describe the processes of distillation and catalytic cracking in the development of useful fractions from crude oil.

- . Identify water and carbon dioxide as major products of burning fossil fuels and identify other products;
  . Identify carbon as a product of burning fossil fuels in an oxygen deficient environment;
  . Describe the chemical reactions that occur

during the burning of short-chain fossil fuels (e.g., methane).

- Describe how chemicals control burning rate, how octane numbers and gasolines differ, and how these differences relate to evenness of burning.

- . Describe the characteristics of the element carbon that permit the formation of many carbon compounds;
  . Define and describe isomers.

- Describe the production of fuels from wastes.

Motion and Collisions (required option)

The student should be able to:

- Distinguish between first and second collisions in car accidents, and identify the effects of each.

- Describe how changes in speed and direction affect a car and its passengers. (State Newton's First and Second Laws of Motion and apply them to collisions between two objects of different masses.)

- Identify ways that energy is conserved during car collisions.

- Calculate the total momentum and total velocity of automobiles in inelastic collisions.

- Use vectors to calculate the resultant force on a car traveling around a curve.

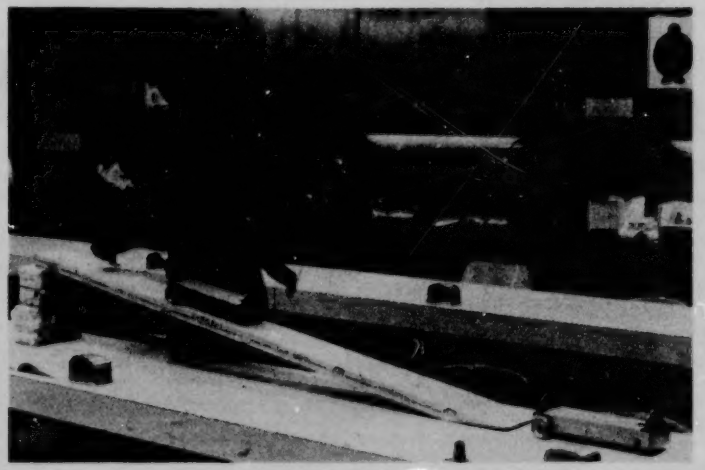
- Apply Newton's Second Law of Motion to automobile acceleration.

- Describe the safety features of a padded dashboard, a seat belt system, and an air bag system.

- Describe when seat belts work best to reduce injuries to passengers in collisions.

- Compare the injuries of belted and unbelted passengers reported in graphs or tables.

- Explain how effective air bags are in reducing injuries to passengers.



- Describe safety features which have been developed for modern highways.

- . Identify statements based on facts, not opinions, in the mandatory seat belt law debate;
  . Explain the arguments for or against a seat belt law.

- Identify statements based on facts, not opinions, relative to safety design in automobiles.

Cells (required option)

The student should be able to:

- Identify the five main parts of a cell and describe their functions.

- Recognize the major cytoplasmic inclusions in a drawing and describe their functions.

- . Describe the process of DNA replication and its importance to cell division;
  . Identify the five principal stages of mitosis in order and describe what occurs during each stage.

- Distinguish between normal healthy body tissues and those that are cancerous.

- Describe the characteristics of cancer cells and the methods by which they spread.

- Identify the seven warning signals of cancers and the type of cancer associated with each signal.

- Describe the causes, symptoms, diagnoses and treatments for the most common types of cancer.

- Describe what body condition and actions of a person can increase the risk of developing cancer.

- Describe what is meant by probability statements that relate cigarette smoking to lung cancer.

- Identify and apply common diagnostic techniques for finding cancer.

- . Interpret a survival rate graph for cancer victims;
  . Identify three common methods of treating cancer and compare their effectiveness.

- . Interpret a cancer death rate graph;
  . List which kinds of cancer correlate on a graph with increasing or decreasing death rates in males and females, giving possible reasons for these trends.

- Describe the damaging side effects of cancer treatment and explain why they occur.

- Describe how the Curies and Becquerel contributed to cancer treatment and research.

- . Describe the cause of warts, moles, freckles, and sun tans and their relationship to cancer;
  . Recognize the difference between warts,

moles and freckles.

- Describe the current status of cancer research and the outlook for finding the cause of cancer.

Nutrition (required option)

The student should be able to:

- Identify the structural formulas of carbohydrates, fats, and proteins.

- Describe the process whereby the body reassembles food protein into body cell protein.

- . List the three major nutrient food groups;
  . Describe why the body needs the three nutrient food groups;
  . List the four major food groups as specified by the Canada Food Guide;
  . Identify the correct food group for a given food;
  . Infer the presence of water and carbon in certain foods as a result of heating.

- . Classify the foods eaten in various categories for a single day's food consumption;
  . Interpret data accumulated to write out a food intake score.

- . Explain the importance of vitamins and minerals in a balanced diet;
  . Identify symptoms of vitamin and mineral deficiency.

- . Determine whether or not he(she) is eating a balanced diet;

. Express what is meant by minimal daily allowances.

- . Define operationally a food calorie, joule and kilojoule;
  . Interpret calorie data charts to calculate total calories used in a typical day;
  . Explain why a certain amount of food calories are needed to maintain the body;
  . Identify high and low calorie foods.

- . Make simple measurements of skinfold thickness;
  . Interpret data about age and skinfold thickness;
  . Describe three health hazards of being overweight and two hazards of crash diets.

- . Explain why a sound weight control plan should involve proper nutrition and exercise;
  . Calculate basal metabolic rate.

- Describe some successful techniques for preventing overeating.

- Use accepted guidelines for evaluating the effectiveness and suitability of common diet plans.

- . Explain how tooth decay happens;
  . Describe ways of reducing tooth decay.

- Interpret information found on nutrition labels on packages.

- Test foods for the presence of starches, sugar, fats and proteins.

- . Describe the role of technology in improving the kind and quality of food in Canada;
  . Outline some problems associated with the use of pesticides and fertilizers.

- . Explain the major differences in food quantit and quality between developed and undevelope countries;
  . Interpret data related to world food production.

Air and Its Components (option)

The student should be able to:

- Investigate the kinds of particulate matter in air.

- Describe the structure and composition of the atmosphere.

- Describe the function of the major components o air.

- Describe some basic properties of oxygen.

- State the role of oxygen in the corrosion of metals and compare methods of preventing corrosion.

- Describe some basic properties of carbon dioxic

- Identify the critical properties of carbon diox

that apply in specific cases such as baking and extinguishing fires.

- Define air pollution and describe some forms and causes.

Particle Theory (option)

The student should be able to:

- Apply concepts of the particle theory to:
  . the effect of heat upon the conversion of a liquid, such as mercury, to a gas;
  . the process of diffusion in gases:
    - describe the factors affecting concentration,
    - describe the factors affecting the rate of diffusion;
  . the process of diffusion in liquids.

- Apply concepts of the particle theory to:
  . the evaporation of a liquid;
  . humidity and its effect on comfort in the home:
    - define absolute and relative humidity,
    - relate humidity to human comfort.

- Apply concepts within the particle theory to evaporation and condensation within refrigerator units.

- Define viscosity and relate viscosity to the particle theory; test liquids for viscosity.

- Apply concepts within the particle theory to:
  . temperature-volume relationships in gases,

liquids, and solids;
. pressure-volume relationships in gases.

SCIENCE 101 OBJECTIVES

Following are the objectives for Science 101.

Motion and Collisions (compulsory)

The student should be able to:

- Distinguish between first and second collisions in car accidents, and identify the effects of each.

- Describe how changes in speed and direction affect a car and its passengers. (State Newton's First and Second Laws of Motion and apply them to collisions between two objects of different masses.)

- Identify ways that energy is conserved during car collisions.

- Describe the safety features of a padded dashboard, a seat belt system, and an air bag system.

- Describe when seat belts work best to reduce injuries to passengers in collisions.

- Compare the injuries of belted and unbelted passengers reported in graphs or tables.

- Explain how effective air bags are in reducing

injuries to passengers.

- Describe safety features which have been developed for modern highways.

- . Identify statements based on facts, not opinions, in the mandatory seat belt laws debate;
  . Explain the arguments for and against a seat belt law.

- Identify statements based on facts, not opinions, relative to safety design in automobiles.

Chemical Reactions (compulsory)

The student should be able to:

- Describe the alchemist's theory of matter, why the theory is no longer accepted, and why theories may change or disappear over time.

- Describe and apply Dalton's concept of atoms and elements.

- Use different models of atoms to predict the structure of the atom and the properties of the parts of the atom.

- Describe the differences between an atom and an ion.

- Describe the formation of an ionic bond and identify compounds that contain ionic bonds.

- Describe the formation of a covalent bond and identify molecules with covalent bonds.

- Describe the difference between polar and non-polar covalent bonds, and identify molecules with each bond type.

- Describe how a metallic bond is formed, and identify substances that contain metallic bonds.

- Use a table of combining powers to derive the formula of a compound, once given the name, and to state the name, once given the formula.

- Explain the basis for the arrangement of elements in the modern periodic table.

- Describe the factors used by Mendeleev in developing the classification of elements and infer how the classification proved useful in characterizing unknown elements.

- Use the periodic table to determine whether an element is a metal or non-metal.

- Use the periodic table to determine the combining power(s) of an element and use combining powers to determine chemical formulas.

- Use the periodic table to determine whether an element tends to lose or gain electrons.

- Describe the characteristics of a chemical reaction and observe whether a chemical reaction has occurred.

- Write balanced equations for statements describing chemical reactions and identify reactants and products.

- Describe what happens in terms of electron loss or gain in reduction or oxidation during a chemical reaction.

Cells (compulsory)

The student should be able to:

- Identify the five main parts of a cell and describe their functions.

- Describe the characteristics of cancer cells and the methods by which they spread.

- Identify the seven warning signals of cancers and the type of cancer associated with each signal.

- Describe the causes, symptoms, diagnoses and treatments for the most common types of cancer.

- Describe what body condition and actions of a person can increase the risk of developing cancer.

- Describe what is meant by probability statements that relate cigarette smoking to lung cancer.

- Identify common diagnostic techniques for finding cancer.

- . Interpret a survival rate graph for cancer victims;
  . Identify three common methods of treating cancer and compare their effectiveness.

- . Interpret a cancer death rate graph;
  . List which kinds of cancer correlate on the graph with increasing or decreasing death rates in males and females, giving possible reasons for these trends.

- Describe the damaging side effects of cancer treatment and explain why they occur.

- Describe how the Curies and Becquerel contributed to cancer treatment and research.

- . Describe the cause of warts, moles, freckles, sun tans and their relationship to cancer;
  . Recognize the difference between warts, moles and freckles.

- Describe the current status of cancer research and the outlook for finding the cause of cancer.

Ways We Learn (Compulsory)

The student should be able to:

- Identify the principal factors that motivate people's actions.

- Identify the principal ways people learn skills.

- Identify the principal factors that prevent learning.

- Describe the methods that are used to improve a person's memory and know the principal reasons a person remembers or forgets things.

- Identify how rules, formulas and laws are helpful in solving problems, and describe the four principal steps used to solve problems.

- Describe the effect of practice on learning and on how much is forgotten between learning sessions.

- Describe how physical handicaps such as blindness affect learning and how people adjust by improving other feedback systems.

- Learn a new skill using proper learning techniques.

- State how a behaviorist explains human learning, and describe the works of Pavlov and Skinner and their importance in the study of human learning; e.g., habits can be learned or extinguished by classical conditioning (paired stimuli) or by reinforcement of approximations of the desired behavior.

- . State how cognitive psychologists explain human learning;
  . Describe the works of Ausubel and Bruner and the importance of these works in the

study of human learning.

- Analyze the results of an aptitude test and correlate aptitudes to careers.

- Establish what his or her own aptitude is.

Fossil Fuels (option)

The student should be able to:

- Describe how fossil fuels may have been formed and why the supply is limited.

- . Describe how recent trends in North America's use of fossil fuels compare with trends in world use;
  . Identify the most abundant and least abundant fossil fuels.

- Describe the pros and cons of using coal rather than oil or natural gas in terms of availability, environmental effects, and efficiency.

- Describe the environmental effects of extracting and transporting fossil fuels.

- Describe how pollutants from car exhausts can be reduced by catalytic converters.

- Describe how energy can be converted from one form to another and show how energy is conserved in the process; describe how useful energy can be lost during conversion.

- Describe the processes of distillation and catalytic cracking in the development of useful fractions from crude oil.

- . Identify water and carbon dioxide as major products of burning fossil fuels and identify other products;
  . Identify carbon as a product of burning fossil fuels in an oxygen-deficient environment;
  . Describe the chemical reactions that occur during the burning of short-chain fossil fuels (e.g., methane).

- Describe how chemicals control burning rate, how octane numbers and gasolines differ, and how these differences relate to evenness of burning.

- Describe the production of fuels from wastes.

Know Your Car (option)

The student should be able to:

- Describe the electrical system in an automobile:
  . Describe a complete circuit;
  . Explain the structure and function of a car battery;
  . Explain the care and charging of a battery as well as the clues that indicate a battery is about to fail;
  . Explain the function of spark plugs and the type of defects that cause spark plug failure;
  . Explain the function of the coil, points, and capacitor in an ignition system; test for spark production; discern the differences among common types of ignition systems;
  . Explain the function of the distributor and the importance of setting the timing.

- Describe how liquid cooling systems work in an automobile:
  . Describe the common causes of overheating, the methods of circulating fluid, and the reason antifreeze may be used in all climates;
  . State reasons for pressurizing liquid cooling systems and describe the function of an overflow reservoir;
  . Describe the thermostat in terms of feedback control.

- Describe the functions of the parts of the fuel system:
  . Explain the functioning of a carburetor on the basis of scientific principles;
  . Describe the causes of some common troubles with an ordinary carburetor system.

- . Describe the products of complete and incomplete combustion;
  . Relate the effect of catalytic converters to the kinds of pollutants produced and the nature of the gasolines required.

- Describe the function of lubricants and factors to consider in their selection.

- Compare automobiles in terms of engine displacement, power and compression ratio.

- Define the effect of tire pressure on traction, tread wear, safety, fuel economy and riding comfort:
  . Define pressure in pascals and calculate pressure when force and surface areas are provided;

. Relate the force exerted by an automobile to tire pressure;
. Explain how underinflation and overinflation affect tire wear, traction, comfort, and fuel economy.

Nutrition (option)

The student should be able to:

- . List the three major nutrient food groups;
. Describe why the body needs the three nutrient food groups;
. List the four major food groups as specified by the Canada Food Guide;
. Identify the correct food group for a given food;
. Infer the presence of water and carbon in certain foods as a result of heating.

- . Classify the foods eaten in various categories for a single day's food consumption;
. Interpret data accumulated to write out a food intake score.

- . Explain the importance of vitamins and minerals in a balanced diet;
. Identify symptoms of vitamin and mineral deficiency.

- . Determine whether or not he or she is eating a balanced diet;
. Express what is meant by minimal daily allowances.

- . Define operationally a food calorie, joule and

kilojoule;
. Interpret calorie data charts to calculate total calories used in a typical day;
. Explain why a certain amount of food calories are needed to maintain the body;
. Identify high and low calorie foods.

- . Make simple measurements of skinfold thickness;
. Interpret data about age and skinfold thickness;
. Describe three health hazards of being overweight and two hazards of crash diets.

- . Explain why a sound weight control plan should involve proper nutrition and exercise;
. Calculate basal metabolic rate.

- Describe some successful techniques for preventing overeating.

- Use accepted guidelines for evaluating the effectiveness and suitability of common diet plans.

- . Explain how tooth decay happens;
. Describe ways of reducing tooth decay.

- Interpret information found on nutrition labels on packages.

- Test foods for the presence of starches, sugar, fats and proteins.

- . Describe the role of technology in improving t kind and quality of food in Canada;

. Outline some problems associated with the use of pesticides and fertilizers.

. Explain the major differences in food quantity and quality between developed and undeveloped countries;

. Interpret data related to world food production.

Food and Microorganisms (option)

The student should be able to:

- Identify some common microorganisms without the aid of a microscope.

- State the conditions required for micro-organisms to grow.

- Control certain variables in preparing microorganism cultures.

- Describe how microorganisms can aid in food and beverage making.

- Demonstrate the preserving of foods by preventing the growth of microorganisms on them through drying, lowering pH, increasing or decreasing temperature, and canning.

- Describe the causes and symptoms of food poisoning.

- Identify arguments for and against the use of food additives.

- Describe the importance of bacteria in the nitrogen cycle.

Household Energy (option)

The student should be able to:

- Describe the various sources of energy for the home and their cost.

- Compare the cost of various forms of energy.

- Compare the power used by common household appliances.

- . Describe the operation of heating and cooling systems and compare their efficiency and cos
  . Describe how human comfort and energy consump tion are related.

- . Measure the effectiveness of an insulating material in slowing heat flow;
  . Describe the benefits of insulating a house.

- Describe the greenhouse effect and its advantag for home heating.

- Observe and describe methods for conserving energy.

Fire (option)

The student should be able to:

- Apply the Law of Conservation of Mass to a comp son of the modern theory of combustion and the

phlogiston theory.

- Show that substances can be classified on the basis of combustibility.

- State the three factors necessary for a fire to occur:
  . a combustible material;
  . enough heat to bring a fuel to its ignition point;
  . the presence of oxygen.

- State that the combinations among atoms are changed in the chemical reaction of burning and that atoms are conserved. (Balance simple equations of burning.)

- Describe three general ways to control fire.

- Describe the ways that fire can be the direct or indirect cause of injury and ways to reduce the possibility of injury or death in fires.

- Describe the characteristics common to explosions; identify the factors that can increase the possibility of explosions occurring; and apply this information to examples.

- . Identify safe and unsafe procedures for storing and using flammable materials;
  . Apply safety procedures for developing escape routes in the home.

- Describe ways in which the rate of burning of flammable materials (clothes) can be retarded through the use of chemicals.

Science and Humanity (option)

The student should be able to:

- Distinguish between observation (direct and indirect), inference, and models (theories); describe how theories and thus "truth" may change in science.

- Describe how science and technology may affect the job market.

- Describe the trade-offs involved in the application of scientific-technological research to societal problems.

Buying and Selling (option)

The student should be able to:

- Analyze an ad to identify factual statements, opinions, misleading statements, and catchy but irrelevant information.

- Describe how techniques such as repetition, association, and catchy words are used in advertising.

- Describe the effectiveness of slogans and jingles in ads.

- Describe how music, voices, and sound effects are used in ads to appeal to the emotions of the listener.

- Identify eight categories of psychological needs and describe how these are appealed to in ads.

- Categorize ads in terms of the human needs, wants, or wishes they appeal to: sex appeal, success, novelty, conformity, independence, knowledge, public service, self-love and utility.

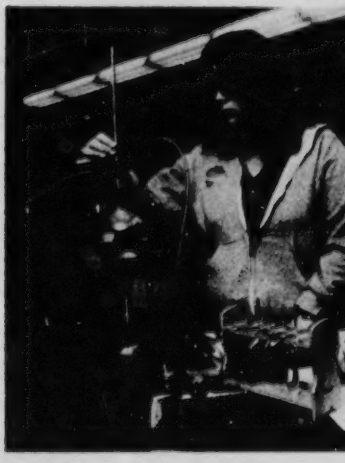
- Identify the target audience of an ad and describe how the ad uses color, lighting, camera angle, models, props and background to appeal to that group.

- Describe and use a technique for determining psychological preferences.

- Develop and administer a survey to identify individuals' brand preferences or the effectiveness of advertisements.

- Describe how the shape of a package can affect a person's estimate of the weight or volume of the contents.

- Describe how logical understanding of volume



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varies among persons.

- Describe at least three different sources of information about consumer products (labels, ads, consumer magazines, test reports, etc.).
- Compare different brands of food by using product labels.
- Describe how various brands/forms of the same type of food can vary.
- Calculate unit prices of consumer products.
- Describe how computers are used for handling charge accounts and how to have computer errors rectified.

DESIGN OF SCIENCE 100

The design of Science 100 attempts to provide for these assumptions:

- A major emphasis should be placed on the process skills of gathering and manipulating data, in order that students attain both skills and concepts in preparation for future science courses. This emphasis is accomplished best by an approach which uses laboratory activities, questions, and the gathering and interpretation of data from many sources. The objectives for both compulsory and required option topics imply this approach. Further, activities designed to develop both process skills and concepts are recommended later in this guide.

- The course should examine the effects of science-technology upon the individual or society. This goal is developed in the optional units in particular. However, it can also be developed in the other units by extending the science concepts with some practical applications. For example, the concept of density can be applied to testing the viscosity of various motor oils.

- The course should offer biology option topics in order both to vary the kinds of applications that can be made in the development of the science-technol goal and to familiarize students with some basic biological concepts. In keeping with this assumption

the units "Cells" and "Nutrition" are offered as options.

- Process skills should be developed and used, not only in reaching conclusions about scientific concepts but also in making technical applications; that is, they are equally important in all units, whether the focus is on concepts from physical or biological science or on issues related to science-technology.

- The course should be flexible because the nature of the student population and the organization of schools vary extensively. In Science 100 choices can be made among optional topics, possible teaching approaches, available teaching materials, and patterns which allow individualized or group-centred organization of students. In addition, the degree or rigor in the course can be adjusted by adding quantitative activities or problems from various sources, or by using additional options.

- The guide should specify objectives as clearly as possible in order to provide direction and to represent the curriculum.

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- The time allotment for Science 100 should be 110 hours.

GENERAL DESIGN: TOPICS

COMPULSORY TOPICS (represents 60-70% of available time)	REQUIRED OPTIONS (minimum of 3 to be chosen)	OTHER OPTIONS (at least one)
Measurement and Experimentation . use of SI units for length, volume and mass . laboratory skills for measuring length, volume and mass Characteristics of Matter . physical properties of solids and liquids . properties of solutions . application of a simple particle model Separation of Substances . characteristics of solutions . separation techniques for mixtures	Fossil Fuels . oil formation and conversion to fuels . resource limitations . carbon characteristics and isomers Motion & Collisions . velocity and acceleration . Newton's First and Second Laws . safety and collisions . velocity Nutrition . carbohydrates, proteins, fats and enzymes . dietary needs Cells . cell structure . nature and prevention of cancer	Air and Its Components . gases in air . properties of oxygen . combustion-oxidation . prevention of corrosion Particle Theory . diffusion and motion of particles . evaporation, humidity and applications . viscosity of liquids . temperature-pressure relationships and volume Local Options

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SELECTION OF MATERIALS

In this revised course, the curriculum consists of specified objectives for each unit. The texts and modules support the curriculum rather than define it. During the pilot program, a number of teachers found that they could readily produce a more quantitatively oriented course by supplementing the text Physical Science: An Introductory Study with questions from IPS. In selecting materials, teachers and schools should review the suggested support materials and make their selections with the following in mind:

1. the degree to which the materials support the course objectives;
2. the needs and capabilities of the students; and
3. the instructional approach desired and the level of sophistication at which objectives are to be met.

MATERIALS

COMPULSORY TOPICS	REQUIRED OPTIONS	OTHER OPTIONS
Haber-Schaim, Introductory Physical Science OR Andrews, et al., Physical Science: An Introductory Study	Motion-- Packaging Passengers (ISIS) OR Nutrition-- Let's Eat (ISIS) OR Cells-- Cells & Cancer (ISIS) OR Fossil Fuels-- Fossil Fuels (ISIS)	Introductory Physical Science OR Physical Science: An Introductory Study

DESIGN OF SCIENCE 101

The design of Science 101 attempts to provide for these assumptions:

- Initial activities should emphasize concrete experiences, since these are most effective for the Science 101 student. This course attempts to provide students with a variety of activities which enable them to interact with and interpret data.

- The course should reflect both the nature of science and its importance to the individual. Through the development of science concepts and process skills and through the consideration given to the potential strengths and limitations of science, the course attempts to provide students with an understanding of science as both a body of knowledge and a methodology.

- The course should examine the effects of science-technology upon the individual or society in each unit, this goal being central to Science 101.

- The course should offer some biology topics in order both to vary the kinds of applications that can be made in the development of the science-technology goal and to familiarize students with some basic biological concepts. Hence, the units "Cells" and "Nutrition" have been included in the design of Science 101.

- The course should be flexible since a wide variety of students registar in Science 101. This flexibility is represented by the inclusion of option topics in addition to compulsory topics, and by the fact that topics are relatively independent and can be taught in any order. In addition, choices can be made in regard to teaching materials, teaching approaches, and patterns of classroom organization. Individualized or group-centred learning situations are possible.

- The guide should clearly specify objectives in order to provide direction and to represent the curriculum.

- The time allotment for Science 101 should be 111 hours.

GENERAL DESIGN: TOPICS

COMPULSORY TOPICS (represents 50-60% of available time)	OPTIONS (Minimum of four expected. Units should support the science/technology/societal goal.)	
Motion and Collisions . conservation of energy . safety in automobile collisions	Fossil Fuels . finiteness of resources . conversion of crude to products . energy conversion	Household Energy . energy transformation . conservation . alternate sources
Chemical Reactions . chemical reactions . periodic table . chemical equations	Know Your Car . cooling, electrical and other systems; their structure, function and control	Fire . combustion and its control . safety
Cells . structure and function of cells . prevention and control of cancer	Nutrition . basic foods and proper diet	Science and Humanity . nature of science
Ways We Learn . factors affecting learning . techniques to improve learning	Foods and Microorganisms . factors affecting growth of bacteria . control of growth	Buying and Selling . comparison buying . factors affecting consumer preference
		Other Possibilities and Local Options, e.g., . energy conversion . science and agriculture

SELECTION OF MATERIALS

In this revised course, the curriculum consists of specified objectives for each unit. The texts and modules support rather than define the curriculum.

In selecting materials, teachers and schools should review the suggested support materials and make their selection with the following in mind:

1. the degree to which the materials support the course objectives;
2. the needs and capabilities of the students; and
3. the instructional approach desired and the level of sophistication at which objectives are to be met.

MATERIALS

COMPULSORY TOPICS	OPTIONS
Motion-- Packaging Passengers (ISIS) Chemical Reactions-- Actions and Reactions (ISIS) Cells-- Cells and Cancer (ISIS) Ways We Learn-- Ways We Learn (ISIS) OR Abraham, et al. Interaction of Matter and Energy. 3rd ed. Sections 3-4 and 8-9 (Note: First to third editions may be used.) Cells-- Cells and Cancer (ISIS) Ways We Learn-- Ways We Learn (ISIS)	Fossil Fuels-- Fossil Fuels (ISIS) Household Energy-- Household Energy (ISIS) Know Your Car-- Know Your Car (ISIS) Fire-- Fire (ISIS) Nutrition-- Let's Eat (ISIS) Food and Microorganisms-- Food and Microorganisms (ISIS) Buying and Selling-- Buying and Selling (ISIS) Science and Humanity-- Abraham, et al. Interaction of Matter and Energy. 3rd ed. Section 3 or 14.

NOTE: Only "core" and "excursion" activities from ISIS are recommended for Science 101. Advanced activities should be reserved for advanced students. Activities should be reviewed before being used.

SI: EFFECTS ON SCIENCE 100, 101

Although a metric system has always been an integral part of the science program, Canada's conversion to SI (Systeme Internationale) will affect some aspects of grade ten science. Advantages of SI are its internal coherence and the ease of conversion from one unit of measurement to another. Some units that have been in common use, however, are no longer acceptable.

A number of basic changes are outlined below. For more complete information, teachers should refer to the Metric Style Guide issued by the Council of Ministers of Education, Canada, or Science Teachers' Guide to Metrication prepared by the Department of Education.[2]

SOME IMPORTANT CHANGES IN THE METRIC SYSTEM	
. Degrees centigrade become degrees Celsius.	°C
. Forces are expressed in newtons. Weight as a measure of force is measured in newtons. Mass is measured in grams and kilograms.	$N=kg\ m/s^2$
. The unit of energy is the joule (J). The calorie is replaced by the joule.	J=N m
. The symbol cc is written as cm^3.	
. Pressure will be expressed in pascals (Pa). Atmospheric pressure is about 100 kilopascals.	$Pa=N/M^2$ k Pa

[2] Metric Style Guide was distributed to schools in 1976; Science Teacher's Guide to Metrication, in 1979. Single copies of the latter may be obtained from Curriculum Services.

Pedagogical Considerations Related to SI

1. Students' previous experience with SI should be determined early.

2. SI should be implemented throughout the science program and other subject areas on a coordinated basis.

3. Concrete examples of new units of measurement should be demonstrated as they become required within the topics studied; for example, the newton of force may be initially developed by lifting or holding different masses, by measuring different masses with a spring scale graduated in newtons, and by determining the force of friction of objects sliding over a surface.

4. Relationships among units can be introduced when a new unit is presented; however, numerical conversions should be developed as the need arises.

5. SI measurements should be related to students' experience.

6. Conversions between SI and non-SI units should be avoided.

7. Published materials employing SI should be used wherever possible.

SI and Laboratory Equipment

Most equipment used in laboratories is SI-compatible. Measuring instruments that may be affected, however, are those that provide direct readings in units of force or pressure. They can be adapted by replacing the scale with an overlay expressed in newtons or pascals.

SPECIAL NEEDS STUDENTS

Students with special needs are those with handicaps, whether physical, cultural, emotional or intellectual, those who have been identified as slower learners, and those who are gifted or talented. Students in each of these groups require programs that are adapted to their needs. Suggestions for modifying the program are discussed below.

HANDICAPPED STUDENTS

The educational philosophy currently favored for dealing with handicapped students is normalization, a philosophy that, in many cases, has resulted in the mainstreaming of these individuals. However, a key concept of normalization is the "least restrictive placement" which implies that all special needs students should not be mainstreamed.

Integration into the regular program will depend upon a thorough identification of and attention to the needs of special students. These needs can be assigned to one of the following four categories:

Physical	- general health disability, deafness or hearing impairment, blindness or visual impairment, orthopedic handicap.
Cultural	- inadequate language development or experiences in growth.
Emotional	- problems with personal relationships, mental illness.

Intellectual - underdeveloped cognitive ability, especially in the areas of conceptualization and abstract thinking.

Students with needs in any of these categories may be mainstreamed depending on the degree of the need, but there are at least three conditions which may be considered essential for successful mainstreaming.

1. Good communication must exist among the student, classmates and teacher.
2. The student must be socially acceptable to the class.
3. The student's intelligence and background must enable him/her to adapt to the program content and demands, to whatever extent it is modified.

SLOWER LEARNERS

Not all special needs students will have significant intellectual or physical handicaps. Indeed, the majority of students labelled "slow learners" come from cultural or socio-economic environments that differ from the norm. Whether such students simply learn more slowly or whether their potential for learning is inherently limited is a subject of considerable academic debate. The progress of students who have been identified as slower learners in the regular program should be monitored closely. If adaptation of the regular program does not meet their needs, then these students should be transferred to

another program.

Modifying the Program

Student background and experience--including lifestyl interest, motivation--are the most important factors in determining the extent to which a handicapped student or slower learner may be accommodated in the regular program. Consideration of these factors as well as of a student's cognitive ability, his or her learning strengths and weaknesses, should determine the selection of appropriate teaching strategies and materials. Some specific suggestions for modifying the program to suit the needs of these students are listed below.

1. Choose those options in this guide whose content is appropriate to student background/ interest, or use new content commensurate with the overall objectives.

2. Select materials appropriate to the student's reading level. If there is a foreign languag problem, use E.S.L. teaching materials, developed by the Department of Education.

3. Identify and attempt to use the student's preferred learning modality; i.e., students can be primarily visual, auditory or tactile/ kinesthetic learners.

4. Teach from the concrete to the abstract. Use a "life skills" approach.

5. Enhance the student's self-concept by providi

activities which will assure recognizable achievement.

6. Be sure the student knows exactly what is required. Give clear instructions to minimize misunderstanding. Teach one skill or objective at a time. Use only one sensory approach at a time to avoid student confusion.

7. Use community resources. Develop activities so that students see the practical value and application of what they learn in class.

8. Consider transferring the student into another program if the previous adjustments prove ineffective.

GIFTED OR TALENTED STUDENTS

A gifted student in science may demonstrate one or more of the following characteristics:

- an outstanding performance in most academic subjects;
- an ability to read prolifically and, consequently, to read and understand scientific textbooks and articles;
- a preference for independent work with little teacher direction;
- a curiosity towards abstract concepts;

- an assumption of responsibility.

Since the Science outline identifies the minimum program for students, and since gifted students can attain the course objectives in less time than other students, teachers of gifted students are faced with the challenge of enriching the program with stimulating and worthwhile activities, as the following suggest.

1. Provide higher level problem-solving, researc reading, and writing skills activities than those required for regular programs.

2. Emphasize reading in science by providing the student with a wide variety of materials and resources, such as professional journals and magazines.

3. Encourage the development of the student's manipulative and intellectual skills.

4. Encourage independent activities and projects which allow the student to pursue problems of special interest.

5. Organize seminars at which students can present papers and special projects for ultimate submission to journals and newpapers.

6. Use science clubs and fairs to maximum advantage.

7. Promote computer use in science.

8. Encourage peer tutoring.

9. Enrich the program rather than accelerate the student.

STUDENT EVALUATION

Evaluation should be a continuous, integral part of the teaching process and should not be restricted to the completion of a unit or term. Frequent brief tests provide early feedback for both the teacher and students. Such an evaluation system is important because it indicates how a student learns, and measures both student growth and achievement as well as whether the goals and objectives of the science program are being met. Listed below are some evaluation techniques.[3]

Informal Assessment. This involves a periodic one-to-one demonstration of the student's ability to perform a specified lab-related skill; e.g., making a microscope slide.

Short Answer Questions. These questions, answered by a word or phrase, often require the process of recall; e.g., How many newtons does it take to support 3 kg at the earth surface? _____
What is the symbol for meters per second? _____

True - False Questions. These can require the recall and recognition of facts and concepts; e.g.,

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[3] This list is adapted from the Ontario Ministry of Education's Intermediate Division Science curriculum guide.

When iron is heated, its density increases.

Multiple Choice Questions. These require the selection of the best answer from a number of possibilities.

Interpretive Exercises. These can measure a variety of objectives, including the student's ability to interpret laboratory experiments and to encounter the process of inquiry; e.g., Which one of the following graphs supports the hypothesis that the population on the earth will shortly reach a critical state?

Mathematical Problem-Solving. Problem-solving using mathematical calculations can be an effective technique for evaluating both mathematical skills and the ability to organize and use related data.

Notes and Reports. Notebooks can contain basic ideas that students are expected to understand. Generally, students should be informed that notes and reports should be written grammatically, spelled correctly, and organized with distinct and sequential headings; they should include important lists, diagrams, graphs, and summaries.

Projects. These can take the form of written papers or working models. Students should be given the criteria which will be used in evaluations; e.g., Are the given data reliable and relevant?

Qualitative Experiments. These can be used to evaluate manipulative and behavioral performance,

such as the taking of safety precautions, the efficient use of equipment, and experimental design. For example, students may be asked to observe, describe and compare everything that occurs when one half of an Alka-Seltzer tablet is dropped into cold water and the other half into warm water.

Quantitative Experiments. These add the dimensions of measurement and counting to the qualitative experiment.

Analytical Exercises. These attempt to evaluate reasoning or critical thinking skills. Questions can be based on factual or fictitious statements and should promote students' attempts to relate cause and effect, to draw inferences, to distinguish fact from fiction, and to develop tentative conclusions; e.g., Answer the following questions, basing your replies on the statement, "The use of penicillin produces bacteria that are resistant to penicillin."

- What does this statement mean?
- What are the main consequences of this fact?
- What is the logical conclusion?
- How does this fact affect you?
- How does it or will it affect your community?

Additional sources of information concerning methods and items of evaluation in science education are:

1. Managing ISIS, Part 7. See for suggested essay question topics.

2. ISIS - Annotated Teachers' Editions (ATE's).

See for suggested essay questions topics.

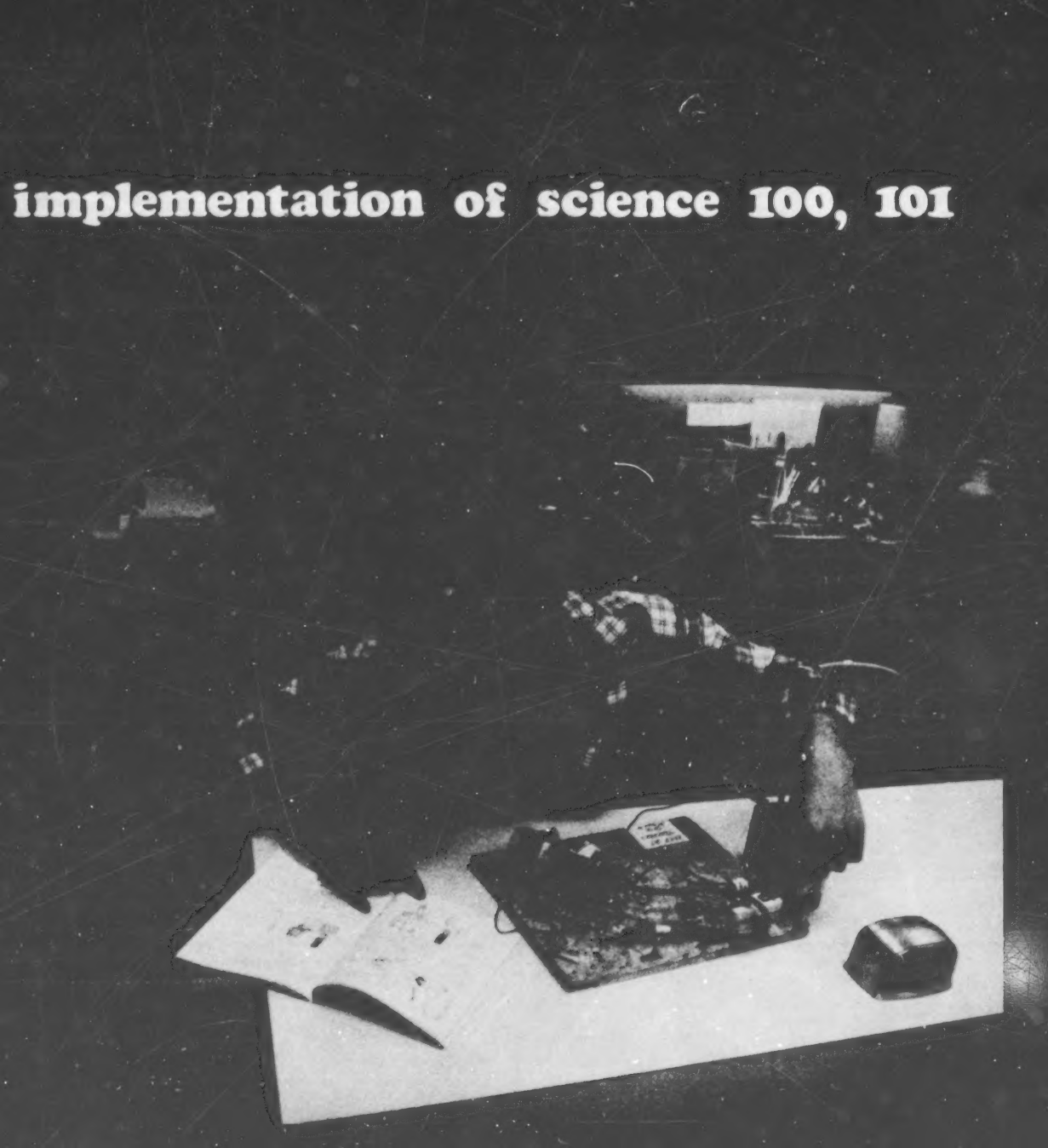
3. ISIS Minicourse Tests. See for items which test specific objectives.

4. Teachers' Guide to Physical Science: An Introductory Study.

5. William D. Hedges, Testing and Evaluation for the Sciences in Secondary School. (Belmont, Calif.: Wadsworth Publishing Company, 1966.)

6. International Reading Association, Improved Reading in Science. (Newark: Delaware, 1976.)

implementation of science 100, 101



INTRODUCTION

The course designs for both Science 100 and 101 provide a "core" or prescribed section and an optional section. This design allows for flexibility in terms of choice among optional units, teaching approaches, and teaching materials. Since there are a number of ways to implement and meet course objectives, teachers should be provided with the time and resources to become familiar with and make decisions about the alternatives.

CURRICULUM MATERIALS FOR SCIENCE 100, 101

1. Introductory Physical Science (IPS)

   - An activity-oriented textbook
   - Very quantitative
   - Recommended for Science 100 only
   - Currently used in Science 100

2. Physical Science: An Introductory Study (PSIS)

   - An activity-oriented textbook
   - Similar to IPS (see above) but somewhat less quantitative
   - recommended for Science 100 only
   - New materials

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[1] For additional information , refer to annotations in Appendix B.

3. Individualized Science Instructional System (ISIS)

   - A series of activity-oriented modules emphasizing the applications of science
   - Flexible material that allows individualization of pace, scope and sequence, can be used in group-oriented situation but will increase costs
   - Some modules recommended for 101 only, others for both 100 and 101
   - Some modules require audio cassettes or other support material
   - New materials

4. Interaction of Matter and Energy (IME)

   - An activity-oriented textbook
   - Recommended for Science 101 only
   - Currently used in 101 level courses

INSTRUCTIONAL OPTIONS

The charts on the following pages present information on how the various approaches work as well as their relative advantages and disadvantages.

ALTERNATIVE APPROACHES TO IMPLEMENTATION

OPTION	HOW IT WORKS	ADVANTAGES	DISADVANTAGES
I Individualized Approach	- The program is activity-oriented. - The program allows students to pace themselves. - Modules can be used in any order. - More than one module can be used in the classroom at any time, at the teacher's discretion. - Modules are flexible enough to allow teachers to insert appropriate supplementary material. - Students can read ahead in their modules every day. - Teachers can closely monitor each student's progress.	- Since the number of texts needed per class is reduced, the cost is reduced. - Most equipment required is likely present in existing labs, fewer pieces of which are required at any one time. - Individual student differences can be accommodated. - For any given activity, students are not faced with large volumes of material to read before they can proceed. - Short-term goals are characteristic of each unit of study. - Students develop responsibility towards their work. - Student-teacher one-to-one contact is maximized. - Close monitoring of	- Some students are slow to adjust to this method of learning. - Some students may attempt to answer the guided questions without having first completed the required reading and/or activity. - There are more opportunities for cheating with testing going on at different times. - Security considerations are greater as equipment is continually left out in the classroom. - Allotment of work space and management of materials is more complicated. - Work may have to be monitored in more than one content area on any given day. - Monitoring of student progress requires more

OPTION	HOW IT WORKS	ADVANTAGES	DISADVANTAGES
		student progress can enable teachers to diagnose more quickly individual problems.	extensive bookkeeping.
II Group-Centred Approach	- The program is activity-oriented. - The class progresses as a group from one activity to another. - The modules can be used in any order.	- Daily classroom routine is more constant. - Teachers are not required to adjust to a new teaching situation. - Security, bookkeeping, and monitoring of daily work are not as extensive as with the individualized approach. - All students write tests at the same time. - No change in existing evaluation practices is necessary.	- Initial expenditures for books is very high. - More lab materials are needed at a given time. - Formal lesson plans are required. - This approach promotes student dependence on teachers. - Direct student-teacher contact may be minimized. - Degree of student-teacher contact may make diagnosing problems difficult. - Individualized differences are not met as efficiently as in an individualized program.
III Group-Centred and Individualized Approach	- See I and II.	- As above for I and II; also--	- As above for I and II; also--

OPTION	HOW IT WORKS	ADVANTAGES	DISADVANTAGES
		- Teachers can experience an individualized program without a total commitment. - A variety of learning and teaching experiences are possible. - Costs can be reduced by using existing texts plus individualized modules. - Less laboratory equipment is required. - Students' responsibility towards their work is encouraged. - Individual student differences may be accommodated. - Direct student-teacher contact is increased. - Close monitoring of student progress enables teachers to diagnose individual problems more quickly.	- Textbooks are not utilized fully. - Transition from individualized to group-centred approach, or vice versa, can present problems for some students. - If individualized modules are tried in the first part of the year, slower students who are unable to complete their modules will be burdened with extra work in the next part of the year when the group-centred approach is used. - Some program objectives may not be achieved.

IMPLEMENTATION COSTS

The cost of implementing the program will vary, depending on factors such as the number of students, the number of classes, the presence of IPS or IME texts in school, and the options chosen.

The major cost is the purchase of new curriculum materials. It should be noted that costs can be reduced if several classes use material concurrently. The laboratory equipment required is

simple; however, some modules will require ancillary materials. The following ranks the major options in order from least to most expensive.

Science 101

1. IME (already in schools, group-centred) plus ISIS (individualized)

2. Totally individualized ISIS

3. IME plus ISIS (group-centred)

4. ISIS (group-centred)

Science 100

1. IPS (already in schools) plus ISIS (individualized)

2. IPS (already in schools) plus ISIS (group-centred)

3. PSIS plus ISIS (individualized)

4. PSIS plus ISIS (group-centred)

SMALL SCHOOLS

Some of the ISIS modules are options in both Science 100 and 101. The two courses can be taught in the same classroom for at least that portion of the program which overlaps. In addition, the low cost of laboratory materials is well

suited to the smaller budgets of small schools.

ROLE OF THE GUIDE AND SUPPORT MATERIALS

The curriculum guide, by defining a set of topics and objectives, represents the basic program. All the recommended instructional materials support the objectives, but to varying degrees. The unit correlation charts in this document provide specific references to the recommended materials, lists of supplementary references and resources, and, where necessary, detailed descriptions of supplementary activities. In cases where Canadian data or information is necessary, supplementary documents will be made available by the Department (Curriculum Services). An example is the document, Fossil Fuels, by the Manitoba Department of Education.

LABORATORY EQUIPMENT

Most of the laboratory activities require simple equipment that is readily available in high school laboratories. Since different instructional materials suggest different laboratory activities, a basic list of laboratory equipment is omitted from this guide. Equipment lists are usually contained in teaching guides that are specific to instructional materials.

IMPLEMENTATION PROCEDURES

The rate of implementation, teachers' backgrounds, instructional approach and equipment requirements

affect the selection and timing of program activities in each school. The following provides general guidelines for the program's implementation.

Year 1

During this year, teachers and administrators should:

1. Develop an awareness of the program--its function and purpose.

2. Decide on a possible major option and become familiar with anticipated changes, both positive and negative.

3. Obtain single copies of all new materials for purposes of examination.

4. Make an inventory of laboratory equipment, student numbers, numbers of classes, etc., to determine budget requirements.

5. For Science 100, choose options among the ISIS modules and consider possible local options. For Science 101, choose either the optional units supported by ISIS modules, Interaction of Matter and Energy, or appropriate local options.

6. Attempt one unit to become more familiar with the approach and materials.

7. Determine in-service needs. An awareness in-service that examines different modes of implementation will be made available through the Department of Education.

Year 2

During this year, teachers and administrators should:

1. Determine whether additional in-services are required; for example, an in-service providing

background on cells and cancer might be useful.

2. Complete implementation of the option chosen, whether individualized, group-centred, or combined.

science 100

MEASUREMENT AND EXPERIMENTATION

Rationale:

This compulsory unit will provide students with information and laboratory activities that will enable them to understand the scientific approach to problem solving and the value of using standardized units of measurement.

Basic References:

1. Andrews, W.A., T.J.E. Wolte, and J.F. Eix. Physical Science: An Introductory Study (PSIS). Scarborough, Ont.: Prentice-Hall of Canada, 1978.
2. Haber-Schaim, U., J.B. Cross, G.L. Abegg, J.H. Dodge, and J.A. Walter. Introductory Physical Science (IPS). 3rd ed. Englewood Cliffs, N.J.: Prentice-Hall, 1977; or 4th ed., 1982.

Supplementary References:

1. Resource Units. ISIS. Lexington, Mass.: Ginn, 1977.
2. Bickel, Charles L. et al. Physical Science Investigations. Boston: Houghton Mifflin, 1979.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to:		
1. Discuss the meaning of the following terms in relation to an experiment: a) variable, b) experimental control, c) hypothesis,	Have students do a variety of lab activities. Emphasize the various processes in pre- and post-activity discussions. Suggested activities include: - Observing the characteristics of a burning candle, and differentiating between observation and	PSIS - all of Chapter 1. ISIS - Resource Unit #15. PSIS - pp. 5-6.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
d) generalization, e) model. Processes involved: - observing - quantifying - formulating hypotheses - controlling and manipulating variables - interpreting data and results - formulating models - inferring - predicting - experimenting	inference. - Using a black box to develop models from indirect evidence. - Using a pendulum to observe the effect of a changing variable such as length or degree of arc upon period. - Observing the effect of distillation on wood.	 PSIS - pp. 16-18. IPS (3rd ed.) - pp. 130-132. IPS (4th ed.) - pp. 163-164. PSIS - pp. 10-14. IPS (3rd ed.) - pp. 3-6. IPS (4th ed.) - pp. 13-18.
2. Identify and use the common SI units for length, area, volume, and mass (using only the prefixes milli-, centi-, and kilo-), and perform the following measurement activities: a) Use a balance correctly; b) Use a metric ruler to determine the dimensions of regular solids; c) Read a graduate;	Have students do a variety of measuring activities using concrete materials. - Measuring length - Measuring area - Measuring volume	 ISIS - Resource unit on "Measuring Length." PSIS - pp. 26-30. PSIS - pp. 35-36. PSIS - pp. 37-44. IPS (3rd ed.) pp. 7-16. IPS (4th ed.) pp. 19-28. ISIS - Resource unit on "Measuring Volume."

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
d) Calculate the volume of a regular solid; e) Determine the volume of an irregular solid by water displacement. Processes involved: - observing - quantifying - interpreting data - communicating	- Measuring mass	PSIS - pp. 45-49. IPS (3rd ed.) - pp. 16-20. IPS (4th ed.) - pp. 28-33.

CHARACTERISTICS OF MATTER

Rationale:

This compulsory unit will introduce students to some common characteristic properties which will help in the identification and classification of matter.

Basic References:

1. Andrews, W.A., T.J.E. Wolfe, and J.F. Eix. Physical Science: An Introductory Science (PSIS). Scarborough, Ont.: Prentice-Hall of Canada, 1978.
2. Haber-Schaim, U., J.B. Cross, G.L. Abegg, J.H. Dodge, and J.A. Walker. Introductory Physical Science (IPS). 3rd ed. Englewood Cliffs, N.J.: Prentice-Hall, 1977; or 4th ed., 1982.

Supplementary References:

1. Bickel, Charles L., et al. Physical Science Investigations. Boston: Houghton Mifflin, 1979.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Recognize that every measurement involves some uncertainty. 2. Calculate the densities of solids, liquids, and gases. Processes involved:	Have students determine the density of: - regular and irregular solids,	PSIS - pp. 55-58. IPS (3rd ed.) - pp. 38-39. IPS (4th ed.) - pp. 55-56.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
- quantifying - observing - interpreting data	- water and other liquids, - carbon dioxide made from alka seltzer and water.	PSIS - pp. 59-60. IPS (3rd ed.) - pp. 39-40. IPS (4th ed.) - pp. 57-59. PSIS - pp. 61-62. IPS (3rd ed.) - pp. 40-42. IPS (4th ed.) - pp. 60-63.
3. Calculate the volume or mass of a solid, liquid, or gas, using the density formula. Processes involved: - interpreting data - making operational definitions	Have students attempt to solve a series of written problems related to density.	PSIS - pp. 65-68. IPS (3rd ed.) - pp. 39, 42, 44, 47, 48. IPS (4th ed.) - pp. 66-68.
4. Describe the differences in the properties of solids, liquids, and gases. Processes involved: - observing - interpreting data	Have students demonstrate the physical differences such as shape, volume, effect of compression, and effect of heat among solids, liquids, and gases.	PSIS - pp. 70-73.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
5. Describe the three states of matter and the factors affecting the changes of state:	Have students:	
a) Describe mass, temperature, volume and density changes with a change in state;	- Observe the change in volume when ice is melted in a graduated cylinder.	PSIS - pp. 73-75.
b) Determine the freezing point (melting point) of a substance;	- Observe temperature changes associated with the melting of ice and the boiling of water.	PSIS - p. 76.
c) Determine the boiling point of a liquid;		
d) Recognize the variables that determine the length of a plateau in a heating or cooling curve;	- Observe the cooling and warming behavior of paradichlorobenzene.	PSIS - pp. 77-78. IPS (3rd ed.) - pp. 30-34. IPS (4th ed.) - pp. 45-52.
e) Describe the effect of adding solutes on the freezing and boiling point of liquids;	- Determine the effect of certain substances on the melting point of ice and on the boiling point of water.	PSIS - pp. 79, 85-86.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
f) Describe the relationships between pressure and the boiling point of a liquid;	- Observe the temperature changes associated with the boiling of water. - Determine the effect of increased and decreased pressure on the boiling point of water.	PSIS - pp. 80-81. IPS (3rd ed.) - pp. 35-36. IPS (4th ed.) - pp. 52-53. PSIS - pp. 82-85.
g) Describe the process of sublimation. Processes involved: - observing - interpreting data - quantifying - communicating	- Observe sublimation of iodine crystals.	PSIS - p. 86.
6. Use a simple particle model of matter to describe the spatial differences between the molecules making up solids, liquids, and gases. Processes involved: - formulating models - inferring	Have students use models to demonstrate the spatial differences.	PSIS - pp. 87-92. IPS (3rd ed.) - Chapter 9. IPS (4th ed.) - Chapter 9.

SEPARATION OF SUBSTANCES

Rationale:

This compulsory unit will introduce students to the manner in which characteristic properties may be used to separate various types of mixtures.

Basic References:

1. Andrews, W.A., T.J.E. Wolfe, and J.F. Eix. Physical Science: An Introductory Study (PSIS). Scarborough, Ont.: Prentice-Hall of Canada, 1978.
2. Haber-Schaim, U., J.B. Cross, G.L. Abegg, J.H. Dodge, and J.A. Walter. Introductory Physical Science (IPS). 3rd ed. Englewood Cliffs, N.J.: Prentice-Hall, 1977; or 4th ed., 1982.

Supplementary References:

1. Bickel, Charles, L., et al. Physical Science Investigations. Boston: Houghton Mifflin, 1979.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Recognize the unique properties and the importance of water. Processes involved: - observing - quantifying - communicating	Have students observe changes in volume as water is cooled to 0°C.	PSIS - pp. 129-132.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
2. Describe the composition of water. Processes involved: - observing - quantifying	Have students decompose water by electrolysis.	PSIS - pp. 133-134. IPS (3rd ed.) - pp. 93-94. IPS (4th ed.) - pp. 119-121.
3. Determine the water content of certain substances. Processes involved: - observing - quantifying	Have students determine the percentage of water in certain foods. Have them determine the percentage of water in certain minerals.	PSIS - pp. 134-135. PSIS - pp. 135-136.
4. Describe the characteristic properties of solutions. Processes involved: - observing - quantifying	Have students dissolve samples of different solids in water and observe the characteristics of the resulting solution.	PSIS - pp. 136-139.
5. Determine and describe the effect of temperature, the nature of the solute, and the nature of the solvent on the solubility of a solid.	Have students: - Add a solid to a liquid and observe the effect of agitation, sub-division, and temperature.	PSIS - pp. 141-142.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - making operational definitions - inferring - interpreting data - observing - communicating - predicting - quantifying	- Add various solutes to various solvents under different temperature conditions and observe qualitatively how each of these affects solubility.	PSIS - pp. 142-144. IPS (3rd ed.) - p. 53 (temperature only). IPS (4th ed.) - pp. 69-76.
	- Determine quantitatively the solubility of salt in water at room temperature and extrapolate this knowledge to solubility curves.	PSIS - pp. 144-147. IPS (3rd ed.) - pp. 51-55. IPS (4th ed.) - pp. 70-76.
	- Prepare a supersaturated solution.	PSIS - pp. 147-148.
6. Describe characteristics of suspensions, emulsions, and colloidal dispersions. Process involved: - observing	Have students prepare a suspension, an emulsion, and a colloidal dispersion and observe the characteristics of each.	PSIS - pp. 148-149.
7. Utilize various techniques to separate various mixtures. Processes involved: - observing - interpreting data - predicting - inferring - quantifying	Have students separate mixtures by: - filtering, - distillation,	PSIS - pp. 149-150. IPS (3rd ed.) - pp. 74,75,79. IPS (4th ed.) - pp. 99-104. PSIS - pp. 151-153. IPS (3rd ed.) - pp. 67-70. IPS (4th ed.) - pp. 89-92.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	- chromatography,	PSIS - pp. 158-160. IPS (3rd ed.) - p. 80. IPS (4th ed.) - pp. 105-106.
	- sedimentation and floc formation,	PSIS - pp. 161-163.
	- fractional crystallization.	PSIS - pp. 163-165. IPS (3rd ed.) - p. 79. IPS (4th ed.) - pp. 104-106.
8. Describe how a mixture of gases can be separated. Processes involved: - predicting - inferring		IPS (3rd ed.) - pp. 80-82. IPS (4th ed.) - pp. 107-110.
9. Relate how petroleum is formed and separated into components. Process involved: - formulating models		PSIS - pp. 154-158. IPS (3rd ed.) - pp. 70-73. IPS (4th ed.) - pp. 92-96.
10. Differentiate between mixtures and pure substances. Processes involved: - making operational definitions - observing		IPS (3rd ed.) - pp. 84-87. IPS (4th ed.) - pp. 110-113.

FOSSIL FUELS

Rationale:

In an era with a so-called energy "crisis", there is a need to begin examining the important role of fossil fuels in society. This unit, a required option, deals with the origins of fossil fuels within the earth and the ways they are processed and used. It focuses on potential reasons for limited supplies of fossil fuels, on the environmental effects of obtaining them, on the products and pollutants formed by burning them, on petroleum refinement, and on choices among available fuels.

Since some of the data in basic references is American, a document containing Canadian data, Fossil Fuels, will be available from Curriculum Services in 1982.

Basic Reference:

1. Fossil Fuels. ISIS. Lexington, Mass.: Ginn, 1980.

Supplementary References:

NOTE: Some of the materials contained in the following list should be screened carefully for bias and used with discretion. Since some of the data will change over a period of time, information will have to be up-dated on a regular basis.

1. Manitoba Department of Education. Fossil Fuels. Teacher's Document, 1982.

2. Tracy, George R. et al. Modern Physical Science. New York: Holt, Rinehart and Winston, 1979.

3. Smallwood, William, and Carl Brown. Challenges to Science: General Science for Tomorrow's World. New York: McGraw-Hill, 1980.

4. Canadian Department of Energy, Mines and Resources.

   - Energy Management for the Future
   - Coal Resources and Reserves of Canada
   - Coal in Canada
   - Renewable Energy Resources: A Guide to the Future
   - Energy Update (1981)
   - The National Energy Program

   Available from Energy, Mines and Natural Resources, 580 Booth Street, Ottawa, Ontario.

5. Manitoba Environmental Council. The Energy Issue: Demand and Supply. Study 9. Winnipeg: Manitoba Environmental Council, 1977.

6. The Petroleum Resources Communication Foundation. Our Petroleum Challenge: The New Era; Great Canadian Energy Quiz (brochure). Available from the Petroleum Resources Communication Foundation, #105-309 2nd Avenue, S.W. Calgary, Alberta.

7. Coal in Canada. Available from the Coal Association of Canada, Suite 590, Three Calgary Place, 355-4th Avenue, S.W., Calgary, Alberta.

8. Oil and Gas: Their Origin, Production and Use. 1979. Available from Imperial Oil Limited.

9. Canadian Petroleum Association. Focus on Energy Series:

   - A Brief History of the Petroleum Industry in Canada
   - The Origins of Oil and Gas
   - The Search, Exploration, Drilling and Production
   - Transportation
   - Refining, Distribution and Marketing
   - Frontier Oil and Gas, Oil Sands and Heavy Oil

   Available from the Public Affairs Department, Canadian Petroleum Association, 1500, 633-6th Avenue, S.W., Calgary, Alberta.

10. Shell Canada. Briefing Papers:

    - World Oil and Gas in 1979
    - Protecting the Environment
    - Oil Products in Canada
    - Transportation Fuels Outlook
    - Perspective on Oil Spills
    - Alsands Project Group
    - St. Boniface Refinery
    - Canada's Oil and Gas Reserves
    - Developing the Tar Sands

    Available from Shell Information Services, P.O. Box 400, Toronto, Ontario.

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11. National Energy Board. Canadian Oil: Supply and Requirements. September, 1978. Canadian Energy Board, 473 Albert Street, Ottawa, Ontario.

12. National Energy Board. Canadian Natural Gas: Supply and Requirements. February, 1979. Canadian Energy Board, 473 Albert Street, Ottawa, Ontario.

13. Canada As a Consumer Society: An Agenda for Action, 1978. Available from the Publications Office, Science Council of Canada, 150 Kent Street, Ottawa, Ontario.

14. Ashcroft, Ken, and Joe Hamill. Chemistry of the Car. Agincourt, Ont.: Book Society of Canada, 1980. Advanced material to be used with caution. Some activities should not be attempted or attempted only with great care.

Audio-Visual References:

1. - Oil Well

   - Oil in Depth: No. 13

   - Refinery Processes

   - This Land

   - Oil Spill: A Progress Report

   Available from the Film Library, Shell Canada Limited, 136 Edward Street, Toronto, Ontario.

2. Our Petroleum Challenge:

   Tape 3a - History of Petroleum

   - Technology of Drilling

   - Rigging Up;

   Tape 3b - Crude Oil

   - Natural Gas

   - Tar Sands.

3. Tar Sands: A Dream Come True (Parts I and II).

4. Shell Canada - The Coal Option.

The materials above (references 2, 3, and 4) are available as video-cassettes. Copies can be made at Instructional Media Services, Department of Education, if blank tapes are sent.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to:		
1. Describe how fossil fuels may have been formed and why the supply is limited.	Diagrams illustrating coal or oil formation can be used in order to develop theories of fossil fuel development.	ISIS - Fossil Fuels, Activity 2. Coal in Canada. General Science for Tomorrow's World (Chapter 4). The Origins of Oil and Gas. Fossil Fuels - Teacher's Document. Videotape: The Coal Option.
2. Describe the processes of distillation and catalytic cracking in the development of useful fractions from crude oil. Processes involved: - observing - inferring	Have students distill and collect fractions of an isopropyl alcohol-water mixture, and compare this to the more elaborate refinery process of fractionally distilling crude oil and catalytic cracking. Demonstration: Heat paraffin with an aluminum powder catalyst to produce a gaseous hydrocarbon from a long-chain liquid hydrocarbon to demonstrate the cracking process or to describe fractions. (Caution.) Discuss cracking and define the role of a catalyst. (See reference.)	ISIS - Fossil Fuels, Activity 3. General Science for Tomorrow's World (Chapter 4). Modern Physical Science (Chapter 12). Oil and Gas: Their Origin, Production and Use. Chemistry of the Car.

11. National Energy Board. Canadian Oil: Supply and Requirements. September, 1978. Canadian Energy Board, 473 Albert Street, Ottawa, Ontario.

12. National Energy Board. Canadian Natural Gas: Supply and Requirements. February, 1979. Canadian Energy Board, 473 Albert Street, Ottawa, Ontario.

13. Canada As a Consumer Society: An Agenda for Action, 1978. Available from the Publications Office, Science Council of Canada, 150 Kent Street, Ottawa, Ontario.

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OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
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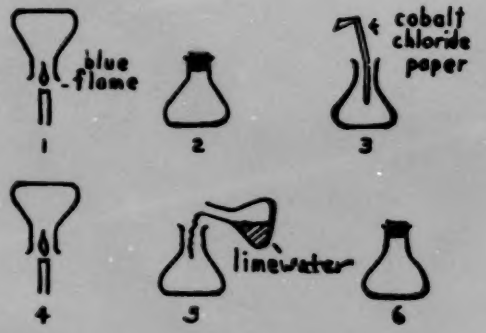
OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
3. a) Identify water and carbon dioxide as major products of burning fossil fuels and identify other products;	With the use of limewater and cobalt chloride test paper, the products of burning natural gas can be identified as water and carbon dioxide.  	ISIS - Fossil Fuels, Activity 4. Modern Physical Science (Chapter 12).
b) Identify carbon as a product of burning fossil fuels in an oxygen deficient environment;	Above a candle or a burner that is set to produce a yellow flame, a piece of aluminum foil can be held. It will soon darken from the carbon particles collecting on it. The activity shows that carbon particles are produced when certain materials like wax or substances like natural gas burn in an oxygen deficient environment. $C H_4$ (methane) + 2 O_2 (oxygen) -> CO_2 (carbon dioxide) + 2 H_2O (water)	

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
c) Describe the chemical reactions that occur during the burning of short-chain fossil fuels (e.g., methane). Processes involved: - observing - inferring	Refer to above activity.	
4.		
a) Describe the characteristics of the element carbon that permit the formation of many carbon compounds;	Carbon and hydrogen models can be used to illustrate carbon's ability to form many compounds; e.g., ethane C_2H_6, ethylene C_2H_4 and acetylene C_2H_2.	ISIS - Fossil Fuels, Activity 12. Modern Physical Science (Chapter 13).
b) Define and describe isomers.	Branched and unbranched hydrocarbon models can be used.	
5. Describe how chemicals control burning rate, how octane numbers and gasolines differ, and how these differences relate to evenness of burning.	Two pieces of paper can be cut and laid on a fireproof pad after one has been soaked in a borax solution. The papers can then be left to dry before being lit with a match. The borax treated paper burns slowly and evenly. (Caution: fumes.) Describe the burning of gasoline in a gasoline engine. Have students examine models of straight chain and branched octane molecules (straight	ISIS - Fossil Fuels, Activity 5. Fossil Fuels - Teacher's Document. General Science for Tomorrow's World (Chapter 16 - "Automobile Power").

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	chain hydrocarbons burn faster), and the relationship of octane rating to burning.	
6. Describe how pollutants from car exhausts can be reduced by catalytic converters.	Students can survey the various pollutants from car exhausts and study how catalytic converters reduce them.	ISIS - Fossil Fuels, Activity 6. General Science for Tomorrow's World (Chapter 16 - "Automobile Power"). Fossil Fuels - Teacher's Document.
7. a) Describe how recent trends in North America's use of fossil fuels compare with trends in world use;	The rate of production and consumption of various fossil fuels in Canada and U.S. over the past 25 years can be compared to their supply.	ISIS - Fossil Fuels, Activity 7. U.S.-oriented data may be replaced with data from: Fossil Fuels - Teacher's Document. Our Petroluem Challenge: The New Era. Coal Resources and Reserves of Canada. Shell Briefing Papers - Canada's Oil and Gas Reserves and Developing the Tar Sands.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Identify the most abundant and least abundant fossil fuels. Processes involved: - inferring - interpreting data		
8. Describe the environmental effects of extracting and transporting fossil fuels.	Discuss methods of extracting and transporting coal and oil. Examples of good environmental management can be contrasted to strip mining and oil spills.	ISIS - Fossil Fuels, Activities 8 and 16. Coal in Canada. Shell Briefing Papers - Protecting the Environment and Perspective on Oil Spills. General Science for Tomorrow's World (Chapter 5) Videotapes: Tape 3b, Tar Sands: A Dream Come True, and The Coal Option.
9. Describe how energy can be converted from one form to another and show how energy is conserved in the process; describe how useful energy may be lost during conversion.	Students can make a steam generator run a simple turbine (miniature generator) to produce a small electrical current. By experimenting with the apparatus, they can see that some useful energy is lost in the conversion process.	ISIS - Fossil Fuels, Activity 9. General Science for Tomorrow's World (Chapter 2).

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - observing - inferring		
10. Describe the pros and cons of using coal rather than oil or natural gas in terms of availability, environmental effects and efficiency.	Students can try by various methods -- scraper, cotton ball, sand, detergent, rolled cloth -- to clean pans of crude oil. All methods have faults, but students can decide which appears to be the best.	ISIS - Fossil Fuels, Activity 10. Refer to objective 8 and supplementary reference list.
11. Describe the production of fuels from wastes. Processes involved: - observing - inferring	A flammable gas can be produced by heating dried grapefruit peel, small pieces of wood splint, and waste paper (garbage) in the process called pyrolysis. The mixture can be heated in a test tube connected to a glass tube assembly for ignition.	ISIS - Fossil Fuels, Activity 15. General Science for Tomorrow's World (Chapter 8).

MOTION AND COLLISIONS

Rationale:

This required option unit deals with the interaction of two objects during collision. Newton's First and Second Laws are introduced and applied, but no emphasis is given to the manipulation and derivation of them. The instructional approach allows for the use of simple activities involving principles of force and motion in collisions. Students can apply these to predict how to decrease the effect of forces on colliding objects, giving consideration to automobile safety and design.

This unit is similar to the one in Science 101; however, it introduces additional objectives that emphasizes a more quantitative approach. If teachers wish to make the unit more rigorous, they can introduce the concepts of speed and velocity; for example, the speed of a cart can be measured with ticker tape. It is also possible to introduce ideas for development by experimenting with reaction time and stopping distance.

Basic Reference

1. Packaging Passengers. ISIS. Lexington, Mass.: Ginn, 1976.

Supplementary References:

1. Andrews, W.A. T.J.E. Wolfe, and J.F. Eix. Physical Science: An Introductory Study (PSIS). Scarborough, Ont.: Prentice-Hall of Canada, 1978.

2. Manitoba Department of Education. Motion and Collisions. Teacher's Document, 1982.

*3. Grime, G. "Accidents and Injuries to Car Occupants Wearing Seat Belts." Automobile Engineer, No. 7, 58 (1968) pp. 292-300.

*4. Saskatchewan Legislative Assembly. "Second Readings of Bill No. 104--An Act to Amend the Vehicles Act (No. 2)." Hansard, Tuesday, May 10, 1977.

*5. Shiels, Carl. "The Effects of Seat Belt Legislation: The Saskatchewan Experience." Paper presented at the 10th Annual Safety Conference, Canada Safety Council, October 16-18, 1978.

NOTE: Asterisks indicate that significant textual excerpts appear in Motion and Collisions, Teacher's Document.

6. Canadian Department of Transport. The Human Collision: How Injuries Occur...How

Seat Belts Prevent Them. Ottawa: Supply and Services, 1981. Single copies are available from the Manitoba Department of Education, Curriculum Services. Limited copies are available.

7. Canadian Ministry of Transport. Road Safety Division. The Reasons Some People Have for Not Wearing a Seatbelt Could Prove Them Dead Wrong.

8. Manitoba Department of Highways and Transportation. Motor Vehicles Branch. Annual Report. Request most recent publication.

9. McCormack, A.J. "Egg Drop: An Invention Workshop." Source Activities. October, 1973, pp. 20-23.

10. Ontario Ministry of Transportation and Communications. System Research and Development Division. Safety Belt Use: A Mandate for Survival.

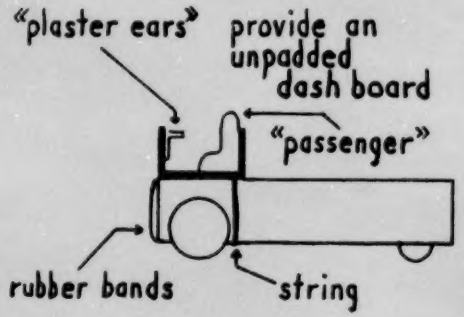
11. U.S. Department of Transportation. Automobile Passive Restraint Systems and What They Mean To You. Washington, D.C.: GPO, 1977. Available from the Allstate Insurance Companies of Canada, 255 Consumers Road, Willowdale, Ont., M2J 1R4.

12. U.S. Department of Transportation. National Highway Traffic Safety Administration. The Case for Seat Belts: Experimental and Statistical Evidence. Washington, D.C.: GPO, 1973.

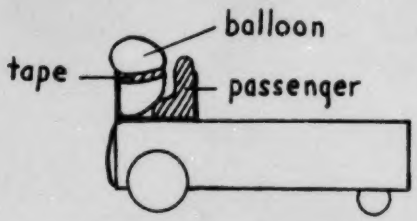
13. Wilde, G.J.S. Shoulder Belt Use Related to Sex, Age, Moving Speed and Weather Conditions. Studies of Safety in Transport. Kingston, Ont.: Queen's University Press, 1977.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Distinguish between first and second collisions in car accidents, and identify the effects of each. Processes involved: - observing - interpreting data	Have students examine photographs of wrecked cars to identify evidence of both first and second collisions. A field trip to an auto wrecking yard, an auto-body shop, or an Autopac claim centre might be arranged. A folder with a set of photos of a car that was involved in a serious accident, together with copies of the official police	ISIS - Packaging Passengers, Activity 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	and Autopac reports of the accident, might be helpful.	
2. Describe how changes in speed and direction affect a car and its passengers. (State Newton's First and Second Laws of Motion and apply them to collisions between two objects of different masses.) Processes involved: - quantifying - predicting - controlling variables - interpreting data and results	Have students simulate automobile collisions using dynamics carts (from the Physics laboratory). To provide reproducible speeds, have them release the carts from a marked position on an inclined plane. Modelling clay cubes can be used to simulate the passengers or luggage. Have students observe what happens to the simulated passengers during collisions with a stationary object and then relate the distance that the cube is thrown to the cart's speed. Have students simulate collisions, this time varying the mass of the stopping object. Placing different weights in a shoe box is a convenient way of doing this. For each different mass, have students measure the distance the stopping object is moved and the distance the simulated passenger is thrown.	ISIS - Packaging Passengers, Activity 3. The Human Collision. ISIS - Packaging Passengers, Activity 3. PSIS - pp. 295-296.
3. Describe the safety features of a padded dashboard, a seat belt system, and an air bag system.	Have each student devise, make and test a package that will enable its contents (a fragile object such as an egg) to survive a 6-metre fall. Place	ISIS - Packaging Passengers, Activity 4. "Egg Drop: An Invention Workshop."

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Process involved: - experimenting 4. Describe when seat belts work best to reduce injuries to passengers in collisions. Processes involved: - observing - interpreting data and results - predicting - experimenting	restrictions on the size of the package (e.g., for an egg, no dimension may be more than 20 cm). Have the students determine the effectiveness of padded dashboards, seat belts, and air bags in simulated collisions. Have them fasten a metallic electric outlet box (with the sides removed) to a dynamics cart as indicated below:  A fairly large passenger can be made from modelling clay. For each colli-	ISIS - Packaging Passengers, Activity 5. NOTE: Other safety features such as collapsing steering wheels, controlled collapsing front ends, and shock absorbing bumpers have been developed and will be provided on newer cars. Various car magazines, as well as Popular Mechanics, often have feature articles related to car safety.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	sion listed below, carts should be released from the same starting position on the ramp (ensuring that they run at the same speed), and they should hit the same wall or immovable object. After each collision, have students record the damage to the passenger. Conditions 1. Passenger Unrestrained. 2. Padded Dash - Place a piece of split rubber tubing over the sharp edge of the "plaster ears." 3. Lap Belts - Fabricate a lap belt for the passenger using a) a thread, b) a shoelace, and c) a rubber band. Compare the effectiveness. 4. 3-Point Belt - Use the most effective material (as determined above) to make a 3-point seat belt (lap and shoulder). 5. Air Bag - Fill a balloon with a small amount of air and fasten it with a strip of masking tape to the front of the dash to ensure that the passenger does not fall out, as the illustration following shows.	Automobile Passive Restraint Systems and What They Mean To You.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
		
5. Compare the injuries of belted and unbelted passengers reported in graphs or tables. Process involved: - interpreting data and results	Have the students examine accident statistics describing injuries to belted and unbelted drivers.	ISIS - Packaging Passengers, Activity 6. The Human Collision.
6. Explain how effective air bags are in reducing injuries to passengers. Processes involved: - interpreting data and results - inferring	Provide descriptive information, diagrams, and/or photos to illustrate how an air bag restraining system works.	ISIS - Packaging Passengers, Activity 7.
7. a) Identify statements based on facts, not opinions, in	Provide an opportunity for students to consider seriously whether Manitoba	ISIS - Packaging Passengers, Activity 8.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
the mandatory seat belt law debate; Processes involved: - classifying - inferring	should pass a law making the wearing of seat belts compulsory. (Ontario and Saskatchewan already have such laws.) Class discussions, debates, panel discussions, etc. can help students to distinguish fact from opinion. The ISIS tape Packaging Passengers provides several arguments for and against mandatory seat belt laws.	"The Case for Wearing Your Seat Belt: If You Don't" in Motion and Collisions - Teacher's Document. The Case for Seat Belts: Experimental and Statistical Evidence. The Reasons Some People Have for Not Wearing a Seatbelt Could Prove Them Dead Wrong.
b) Explain the arguments for and against a seat belt law. Processes involved: - communicating - quantifying		
8. Identify ways that energy is conserved during car collisions. Process involved: - inferring	Provide descriptive information, diagrams, and/or photos to illustrate how the kinetic energy of a moving car is conserved in a collision. Emphasize that the energy is transformed from one form to another (mainly into heat) but that no energy is lost.	ISIS - Packaging Passengers, Activity 9.
9. Identify statements based on facts, not opinions, relative to safety design in automobiles.	Provide information about how automobiles have been made safer over the last ten years or so. The ISIS tape for Packaging Passengers pro-	ISIS - Packaging Passengers, Activity 15. See NOTE for objective 4. "The Case for Wearing Your

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - classifying - inferring	vides a variety of facts and opinions about automobile safety. Help students to distinguish fact from opinion.	Seat Belt: If You Don't" in Motion and Collisions - Teacher's Document.
10. Describe safety features which have been developed for modern highways. Processes involved: - observing - inferring	Provide information about how highways have been made safer over the last ten years (such things as divided highways, improved guard rails, break-away poles, wider highways, and fog lines). Teachers who wish to emphasize the science-society component might wish to introduce some of the following issues and questions: Accident statistics indicate that young drivers have more accidents. Should the minimum driving age be increased from 16 to 18 or 21? Some accidents are caused by mechanical malfunctions. Should every car have to have a safety check done every 6 or 12 months? (Most states in the U.S. require this.) Small cars almost inevitably come out the losers in collisions with large cars. Since small, more fuel-	ISIS - Packaging Passengers, Activity 16. Annual Report.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	efficient cars are needed, should the sale of large cars be banned?	
11. Calculate the total momentum and total velocity of automobiles in inelastic collisions. Processes involved: - quantifying - formulating models - predicting	Define what is meant by momentum. Illustrate the concept, using concrete examples, and show how momentum is conserved in collisions. (Lab activities from PSSC Physics or other Physics texts can be used to develop the concept.) Discuss the problem of collisions involving massive vehicles (such as trucks or large cars) and light vehicles (motorcycles or sub-compact cars). Have students calculate the change in velocity and momentum for each vehicle in such a collision.	ISIS - Packaging Passengers, Activity 11.
12. Use vectors to calculate the resultant force on a car traveling around a curve. Process involved: - quantifying	Illustrate how the parallelogram method can be used to find the resultant of two forces acting on an object. Provide the students with tables giving: the force necessary to accelerate a 1000 kg car at various levels of acceleration (1-5 m/s^2), the centrifugal force required to keep a 1000 kg car turning around a curve of various radii (50-400 m) at different speeds (56-88 km/hr.), and the maximum frictional force between the tires and the	ISIS - Packaging Passengers, Activity 12.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	road surface for a 1000 kg car travelling on dry concrete, dry asphalt, wet asphalt, gravel, snow, and mud. Have the students use these tabulated values to determine whether or not a car will skid in negotiating a turn.	
13. Apply Newton's Second Law of Motion to automobile acceleration. Processes involved: - interpreting data and results - inferring - quantifying	Have the students use Newton's Second law (F=ma) to calculate the force acting on an object, or on its acceleration. Using graphs that show how the negative accelerating force (in G's) acts on a restrained and an unrestrained dummy in a car, illustrate the rapid sequence of events in a collision and the magnitude of the forces involved.	ISIS - Packaging Passengers, Activity 13. "The Case for Wearing Your Seat Belt: If You Don't" in Motion and Collisions - Teacher's Document.

CELLS

Rationale:

A study of normal and cancerous cells has academic and practical merit, both because of the public's general ignorance and neglect of their bodies and because of the high incidence of cancer. This required option unit compares the abnormal condition of cancer cells to the basic makeup and functioning of normal cells and tissues. It emphasizes ways to detect, prevent, and treat cancer.

Basic Reference:

1. Cells and Cancer. ISIS. Lexington, Mass.: Ginn, 1978.

Supplementary References:

1. Pamphlets from Canadian Cancer Society:
   - What is Cancer: Answers to Questions about Cancer
   - Youth Looks at Cancer
   - What Can You Do About Cancer: Cancer Facts for Men
   - Why Learn About Cancer: The Students Look at Cancer
   - Do Not Smoke #5
   - We Wish You Luck: You're Going to Need It
   - What About a Lump in the Breast: Breast Cancer
   - It Could Save Your Life: Breast Self-Examination
   - A Sane Look at Cancer: Cancer Facts for Women
2. Biological Science Curriculum Study. Biological Science: A Molecular Approach (BSCS Blue Version). 4th ed. Lexington, Mass.: D.C. Heath and Co., 1980.
3. Huff, Darrell. How to Lie with Statistics. New York: W.W. Norton and Company, 1954.

Audio-Visual Resource:

1. "The Feminine Mistake." Available from the Canadian Cancer Society.

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OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to:		
1. Identify the five main parts of a cell and describe their functions. Process involved: - observing	Students can prepare cheek cell slides after reading about the cell as the building block of the body. The five important cell parts and their functions can be presented in various kinds of body cells.	ISIS - Cells and Cancer, Activities 2 and 13. BSCS Blue Version - Chapter 13.
2. Describe the characteristics of cancer cells and the methods by which they spread.	Students can answer questions related to the following topics: Cancer is the abnormal division of cells (too fast or more than two from a single division); benign tumors are different than malignant tumors; cancer grows and spreads via blood vessels or lymph nodes.	ISIS - Cells and Cancer, Activity 3.
3. Identify the seven warning signals of cancers and the type of cancer associated with each signal.	Discuss the Canadian Cancer Society's list of warning signals of cancer and the importance of learning these signals and seeing a doctor if a symptom persists for more than two weeks.	ISIS - Cells and Cancer, Activity 4.
4. a) Interpret a survival rate graph for cancer victims;		ISIS - Cells and Cancer, Activity 5.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Identify three common methods of treating cancer and compare their effectiveness. Process involved: - interpreting data	Surgery, radiation and chemotherapy are the most widely used treatments for cancer. The relative effectiveness of the three types of treatment can be discussed.	
5. Describe the causes, symptoms, diagnoses, and treatments for the most common types of cancer.	Some of the symptoms, causes, diagnostic techniques, and treatments for different types of cancer can be learned by playing the DIAGNOSIS game or by referring to Canadian Cancer Society pamphlets.	ISIS - Cells and Cancer, Activity 6.
6. Describe what body condition and actions of a person can increase the risk of developing cancer. Process involved: - predicting	Discuss some of the conditions that are related to incidence of cancer, the high risk conditions that can be controlled by the individual, and those that cannot.	ISIS - Cells and Cancer, Activity 7.
7. Identify and apply common diagnostic techniques for finding cancer. Processes involved: - observing - predicting	Students can take risk tests to determine their relative chances of getting cancer. They should be instructed in self-examination procedures and encouraged to perform these.	ISIS - Cells and Cancer, Activity 18. Pamphlets: What About a Lump in the Breast: Breast Cancer; It Could Save Your Life: Breast Self-Examination; A Sane Look at Cancer:

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
		Cancer Facts for Women.
8. a) Interpret a cancer death rate graph; b) List which kinds of cancer correlate on a graph with increasing or decreasing death rates in males and females, giving possible reasons for these trends. Processes involved: - interpreting data - inferring	Students can use tables and graphs to gain information about trends in the frequencies of cancer occurrence and death.	ISIS - Cells and Cancer, Activity 8.
9. Describe what is meant by probability statements that relate cigarette smoking to lung cancer. Process involved: - interpreting data	Percentages and statements of probability can sometimes be misleading. Students can be exposed to some probability statements containing percentages and determine what those statements do and do not mean.	ISIS - Cells and Cancer, Activity 9. How to Lie with Statistics. Pamphlets: We Wish You Luck: You're Going to Need It and Do Not Smoke #5. Film: "The Feminine Mistake."
10. Describe the damaging side effects of cancer treatment and explain why they occur.	Discuss the undesirable side effects of cancer treatments (surgery, radiation, and chemotherapy) due to the harming of normal cells along with	ISIS - Cells and Cancer, Activity 10.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	cancer cells; discuss, too, the psychological effects that also result and must be treated.	
11. Describe how the Curies and Becquerel contributed to cancer treatement and research.	Discuss how basic scientific research can lead to unanticipated discoveries; the work of Roentgen, Becquerel, and the Curies on X-rays led to the applied use of radiation as a treatment for cancer.	ISIS - Cells and Cancer, Activity 11.
12. Recognize the major cytoplasmic inclusions in a drawing and describe their function.	Have students locate in a drawing the structures of a typical cell and understand what each structure does: mitochondrion, ribosome, nucleus, nuclear membrane, cell membrane, cytoplasm, endoplasmic reticulum, chromosome, nucleolus, centriole, Golgi body. Students should be made aware that parts and functions are still being investigated.	ISIS - Cells and Cancer, Activity 13. BSCS Blue Version - Chapter 13.
13. a) Describe the process of DNA replication and its importance to cell division; b) Identify the five principal stages of mitosis in order and describe what occurs during each stage.	The process of mitosis (cell division) and the reproduction of DNA as explained by the Watson-Crick model can be described using an overhead.	ISIS - Cells and Cancer, Activity 13. BSCS Blue Version - Chapters 11 and 13.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Process involved: - observing		
14. Distinguish between normal healthy body tissues and those that are cancerous. Processes involved: - observing - classifying	A more detailed examination of the structures and functions of body tissues (epithelial, nerve, muscle, and connective) and the microscopic appearance of cancerous tissues can be conducted.	ISIS - Cells and Cancer, Activity 15.
15. a) Describe the cause of warts, moles, freckles, and sun tans and their relationship to cancer; b) Recognize the difference between warts, moles and freckles. Processes involved: - observing - interpreting data	Discuss what causes skin "extras" (warts, moles and freckles), which can become cancerous, and what to do if a wart or mole changes. The relationship of sunburning and tanning to cancer can also be discussed.	ISIS - Cells and Cancer, Activity 17.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
16. Describe the current status of cancer research and the outlook for finding the cause of cancer. Process involved: - interpreting data	Discuss the different leads researchers are following in an effort to find a cure for cancer.	ISIS - Cells and Cancer, Activity 19.

NUTRITION

Rationale:

Since many people overeat and underexercise, information on what food is and how it can be used to produce a healthy body is important to the individual. In this required option unit, students learn what to eat for both weight control and good nutrition. They check their own diets and plan a program of diet and exercise. The approach is generally positive toward the problem of obesity and overweight.

Basic Reference:

1. Let's Eat. ISIS. Lexington, Mass.: Ginn, 1977.

Supplementary References:

1. Ontario Milk Marketing Board. Energetics: Balancing Food Intake With Energy Output. Available free of charge from the Manitoba Milk Producer's Marketing Board, 104-1580 Dublin Avenue, Winnipeg, Manitoba. Note: This package can be obtained only after having taken part in a one-day in-service dealing with the "Energetics" materials. In-services are available on request. Contact the Manitoba Milk Producer's Marketing Board, tel. 786-6063.
2. Australian Science Education Project (ASEP). Foods. Melbourne: GP, 1974. Available from Prentice-Hall of Australia.
3. Robertson, E.C. The Right Combination: A Guide to Food and Nutrition. 2nd ed. Toronto: Gage Educational Publishing, 1980.
4. Health and Welfare Canada. Health Services and Promotion Branch. Nutrient Value of Some Common Foods. Available from the Department of Health and Community Services, 880 Portage Avenue, Winnipeg, Manitoba.
5. Manitoba Department of Education. Computer Services Branch. "DIET C" - Computer Program. Available free of charge from the Department of Education, 1181 Portage Avenue, Winnipeg, Manitoba. A three- to seven-day tabulation of food intake is analyzed by computer, giving the student a complete diet analysis according to Canadian Nutritional Standards.

Audio-Visual Reference:

1. "The Whole Body Manual." Available from the Home Economics Resource Centre, 212-880 Portage Avenue, Winnipeg, Manitoba, R3G OP1.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. a) List the three major nutrient food groups; b) Describe why the body needs the three nutrient food groups; c) List the four major food groups as specified by the Canada Food Guide; d) Identify the correct food group for a given food; e) Infer the presence of water and carbon in certain foods as a result of heating. Processes involved: - observing - interpreting data - classifying	Leaves from plants (celery, lettuce) can be heated to show that they are mostly water and carbon. Sugar can be heated in a foil cup, to show that carbon is its principle constituent and that heat is produced as sugar burns.	ISIS - Let's Eat, Activity 2. ASEP - Foods - Core. Film: "The Whole Body Manual." The Right Combination, Section 1, Chapters 1, 3, 4, 5, 6. Energetics, "Food Classification."
2. a) Classify the foods eaten in various categories for a single day's food consumption;	Students can keep records of daily food intake OR if a computer terminal is available the DIET C PROGRAM can be	ISIS - Let's Eat, Activity 3. Computer Program: "DIET C." The Right Combination,

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	used. A three- to seven- day tabulation of food intake is analyzed by computer, giving students complete diet analyses--according to Canadian Nutritional Standards.	Section 3, Chapter 3.
b) Interpret data accumulated to write out a food intake score. Processes involved: - quantifying - communicating		Nutrient Value of Some Common Foods.
3. a) Determine whether or not s(he) is eating a balanced diet;	The student can list the nutrients which make up a balanced diet in order to determine the degree of balance in his/her diet. The computer printout (Activity 2) can further assess the degree of balance in the student's diet.	ISIS - Let's Eat, Activity 4. ASEP - Foods, Option 5. The Right Combination, Section 3, Chapter 3.
b) Express what is meant by minimal daily allowances.		
4. a) Define operationally a food calorie, joule and kilojoule;	Water can be heated to introduce the concept of the calorie.	ISIS - Let's Eat, Activity 5. ASEP - Foods, Option 5. The Right Combination, Section 1, Chapter 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Interpret calorie data charts to calculate total calories used in a typical day; c) Explain why a certain amount of food calories are needed to maintain the body; d) Identify high and low calorie foods. Processes involved: - predicting - inferring - observing - quantifying - communicating - interpreting data	The number of food calories eaten in a day can be calculated by comparing daily food intake to calorie chart information.	
5. a) Make simple measurements of skinfold thickness; b) Interpret data about age and skinfold thickness;	Skinfold thickness can be measured to determine generally excessive weight.	ISIS - Let's Eat, Activity 6. ASEP - Foods, Option 6. The Right Combination, Section 3, Chapter 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
c) Describe three health hazards of being overweight and two hazards of crash diets. Processes involved: - observing - quantifying - interpreting data - predicting		
6. a) Explain why a sound weight control plan should involve proper nutrition and exercise; b) Calculate basal metabolic rate. Processes involved: - predicting - quantifying	The student can answer questions related to diet and exercise in terms of calories used in physical activities and calorie intake from foods eaten.	ISIS - Let's Eat, Activity 7. ASEP - Foods, Options 2 and 6. Energetics, "Food Selection and Physical Activity."
7. a) Explain the importance of vitamins and minerals in a balanced diet;	Students can identify good food sources for vitamins and minerals and describe the advantages and disadvantages of taking vitamin and	ISIS - Let's Eat, Activity 8. The Right Combination, Section 1, Chapters 7 and 8.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	mineral food supplements.	
b) Identify symptoms of vitamin and mineral deficiency. Process involved: - inferring		
8. Describe some successful techniques for preventing overeating.	Discuss external influences related to overeating and mechanisms of control.	ISIS - Let's Eat, Activity 12. ASEP - Foods, Option 6. Energetics, "Eating Behavior."
9. a) Explain how tooth decay happens; b) Describe ways of reducing tooth decay.	Students can read and answer questions related to food and tooth decay.	ISIS - Let's Eat, Activity 9.
10. a) Explain the major differences in food quantity and quality between developed and undeveloped countries; b) Interpret data related to world food production.	Students can compare the amount of food per person and the quality of the diets in developed countries with those in developing countries.	ISIS - Let's Eat, Activity 10.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
11. a) Describe the role of technology in improving the kind and quality of food in Canada; b) Outline some problems associated with the use of pesticides and fertilizers.	Students can read and answer questions related to technology and its role in improving the kind and quality of food. Information related to Canada is required, and may be obtained from either the Provincial or Federal Departments of Agriculture.	ISIS - Let's Eat, Activity 11.
12. Identify the structural formulas of carbohydrates, fats, and proteins.	Students can identify the characteristic chemical structures of carbohydrates, proteins, and fats by reading and by answering questions about them.	ISIS - Let's Eat, Activity 14. ASEP - Foods, Core.
13. Describe the process whereby the body reassembles food protein into body cell protein.	Students can read about how food proteins are converted into human body-cell proteins.	ISIS - Let's Eat, Activity 15. The Right Combination, Section 1, Chapter 1.
14. Interpret information found on nutrition labels on packages.	Nutrient information is given on labelling. Students can answer questions related to labelling and the consumer.	ISIS - Let's Eat, Activity 17. The Right Combination, Section 3, Chapter 3.
15. Test foods for the presence of starches, sugar, fats, and protein.	Students can perform tests for fats, proteins, and carbohydrates in the laboratory to suggest a perfect food--milk.	ISIS - Let's Eat, Activity 18. ASEP - Foods, Core, Option 1.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - observing - quantifying 16. Use accepted guidelines for evaluating the effectiveness and suitability of common diet plans.		<u>Energetics</u>, "Diet Analysis."

AIR AND ITS COMPONENTS

Rationale:

This option unit allows students to gain knowledge of the important properties of a number of components of air; this knowledge should improve their understanding of the ways that these components affect humankind. Emphasis should also be given to the ways whereby these components can be used effectively and safely.

Basic Reference:

1. Andrews, William A., T.J.E. Wolfe, and J.F. Eix. Physical Science: An Introductory Study (PSIS). Scarborough, Ont.: Prentice-Hall of Canada, 1978.

Supplementary References:

1. Tracy, George R., et al. Modern Physical Science. Toronto: Holt, Rinehart and Winston, 1979.
2. Fire. ISIS. Lexington, Mass.: Ginn, 1977.
3. Things That Last. ISIS. Lexington, Mass.: Ginn, 1977.
4. Fossil Fuels. Teacher's document. Curriculum Services Branch, Manitoba Department of Education, 1982.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Describe the structure and composition of the atmosphere. Processes involved: - observing - inferring - interpreting	Use a diagram representing the different layers of the atmosphere and discuss the different mixtures. Burn a candle in a closed jar system and test the remaining gas for carbon dioxide. Place moistened iron wool into a graduated cylinder that is set in water, and compare its rusting to that of iron wool in a control set; for each, determine the amount of oxygen removed from the air.	PSIS - pp. 220-224. Modern Physical Science - pp. 108-109.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
2. Describe the function of the major components of air.	Discuss oxygen and carbon dioxide in relation to plants and animals. Describe the dilution effect of nitrogen.	Modern Physical Science - pp. 116-117.
3. Describe some basic properties of oxygen. Processes involved: - observing - inferring - interpreting data	Collect oxygen from a compressed gas by the downward displacement method. Record physical and chemical properties; e.g., using the glowing splint test (CAUTION). Teachers may wish to demonstrate the burning of sulfur, charcoal and other substances in oxygen, to be tested with limewater.	PSIS - pp. 228-230. Modern Physical Science - pp. 109-113. ISIS - Fire - pp. 12-15.
4. State the role of oxygen in the corrosion of metals and compare methods of preventing corrosion. Processes involved: - observing - inferring	Discuss the roles of antioxidant alloy and protective coatings. Investigate the effect of HCl (3M) and NaOH (3M) on nails galvanized with zinc, painted and not protected. CAUTION: USE GOGGLES. (Refer to Things That Last.)	PSIS - pp. 231-233. ISIS - Things That Last - pp. 23-27.
5. Describe some basic properties of carbon dioxide. Processes involved: - observing - inferring	Carbon dioxide can be collected from a cylinder of compressed gas and tested using limewater. Dissolved in water, it can be tested for its acid base properties using litmus paper. The density of carbon dioxide can be compared to the density of air. The ability of carbon dioxide to support combustion can be tested.	PSIS - p. 240. Modern Physical Science - pp. 117-118.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
6. Identify the critical properties of carbon dioxide that apply in specific cases such as baking and extinguishing fires.	The pros and cons of various kinds of fire extinguishers and the methods used in extinguishing fires can be compared. Carbon dioxide can be produced using common baking materials.	PSIS - pp. 241-244.
7. Define air pollution and describe some forms and causes.	Discuss various forms and means for decreasing pollution.	PSIS - pp. 244-248. Fossil Fuels - Teacher's Document - pp. 27-29.
8. Investigate the kinds of particulate matter in air. Processes involved: - observing - inferring	A thin film of petroleum jelly on a glass slide can be used to collect particulate matter. Particles can be observed through a microscope, and the types of particle and potential sources recorded and described.	PSIS - pp. 244-248. Modern Physical Science - (Chapter 9).

PARTICLE THEORY

Rationale:

This option unit relates some basic concepts from the particle theory to the behavior of liquids, gases and solids. In addition, the concepts are examined in terms of their use within practical applications.

Basic Reference:

1. Andrews, W.A., T.J.E. Wolfe, and J.F. Eix. Physical Science: An Introductory Study (PSIS). Scarborough, Ont.: Prentice-Hall of Canada, 1978.
2. Haber-Schaim, U., J.B. Cross, G.L. Abegg, J.H. Dodge, and J.A. Walter. Introductory Physical Science (IPS). 3rd ed. Englewood Cliffs, N.J.: Prentice Hall, 1977; or 4th ed., 1982.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Apply concepts of the particle theory to: a) the effect of heat upon conversion of a liquid, such as mercury, to a gas; Processes involved: - predicting - observing	Demonstrate the effects of heat using a mercury demonstration tube (evacuated). Ask students to predict what will happen and then to explain the outcome on the basis of particles.	PSIS - pp. 94-100. IPS (3rd ed.) - pp. 151-154. IPS (4th ed.) - pp. 184-186.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) the process of diffusion in gases: . describe the factors affecting concentration, . describe the factors affecting the rate of diffusion; Processes involved: - predicting - observing	Open an air freshener in one part of the room and discuss its diffusion. Or demonstrate the effect of concentrated HNO_3 on copper in a large container, observing and discussing concentrations as shown by color. Use a diffusion tube with sources of ammonium hydroxide and hydrochloric acid at opposite ends to demonstrate the rate of diffusion. Ask students to relate such factors as molecular weight and temperature to their observations of the rate of diffusion.	
c) the process of diffusion in liquids. Processes involved: - observing - inferring - interpreting data	Place a solid, such as potassium permanganate, in water to demonstrate the diffusion of a solid within a liquid. Ask students to explain observations on the basis of the particle theory.	
2. Apply concepts of the particle theory to: a) the evaporation of a liquid;	Have students observe the effect of a few drops of rubbing alcohol on the back of the hand. Have them take the temperature of alcohol in two dishes --one evaporating normally and the other set in front of an electric fan.	PSIS - pp. 103-110.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - observing - interpreting	A watch glass filled with alcohol can be placed on a shallow glass plate containing water to demonstrate the principle that evaporation is a cooling process. (The cooling of water in a canvas bag and the cooling effect of sweating can also be discussed in reference to this principle.) The formation of dew and fog and the water cycle can also be discussed.	
b) humidity and its effects upon comfort in the home: . define absolute and relative humidity, . relate humidity to human comfort.	Have students describe absolute and relative humidity and relate these to heat control in humans. Have them relate temperature to its effect on humidity. Discuss the effect of humidifiers upon comfort, the use of vapor barriers, and the effect of excessive humidity in houses.	
3. Apply concepts within the particle theory to evaporation and condensation in refrigerator units.	Discuss how refrigerator parts operate. Compare the operation of a refrigerator to that of a heat pump.	PSIS - pp. 111-115.
4. Define viscosity, relate it to the particle theory, and test liquids for it.	Have students compare different grades of motor oil (viscosity) at the same temperatures. Viscosity can be related to the particle theory.	PSIS - pp. 116-118.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
5. Apply concepts within the particle theory to: a) temperature-volume relationships in gases, and in liquids and gases together; Processes involved: - recording - interpreting data b) pressure-volume relationships in gases. Processes involved: - predicting - quantifying - observing - inferring	A flask can be used to record changes in the volume of a gas and a liquid. A volume-temperature apparatus can be used to record changes in the volume of a solid. Weights and a syringe can be used to investigate pressure-volume relationships. These relationships can be plotted on a graph.	PSIS - pp. 118-121. IPS (3rd ed.) - pp. 157-175. IPS (4th ed.) - pp. 190-208.

science 101

MOTION AND COLLISIONS

Rationale:

This compulsory unit deals with the interaction of two objects during collision. Newton's First and Second Laws are introduced and applied, but no emphasis is given to the manipulation and derivation of them. The instructional approach allows for the use of simple activities involving principles of force and motion in collisions. Students can apply these to predict how to decrease the effect of forces on colliding objects, giving major consideration to automobile safety and design.

Basic References:

1. Packaging Passengers. ISIS. Lextington, Mass.: Ginn, 1976.

2. Abraham, Norman, et al. Interaction of Matter and Energy. Inquiry in Physical Science (IME). 3rd ed. Chicago: Rand McNally, 1979.

Supplementary References:

1. Manitoba Department of Education. Motion and Collisions. Teacher's Document.

* 2. Grime, G. "Accidents and Injuries to Car Occupants Wearing Seat Belts." Automobile Engineer, No. 7, 58 (1968), pp. 292-300.

* 3. Saskatchewan Legislative Assembly. "Second Readings of Bill No. 104--An Act to Amend the Vehicles Act (No. 2)." Hansard, Tuesday, May 10, 1977.

* 4. Shiels, Carl. "The Effects of Seat Belt Legislation: The Saskatchewan Experience." Paper presented at the 10th Annual Safety Conference, Canada Safety Council, October 16-18, 1978.

NOTE: Asterisks indicate that significant textual excerpts appear in Motion and Collisions, Teacher's Document.

5. Canadian Department of Transport. The Human Collision: How Injuries Occur...How Seat Belts Prevent Them. Ottawa: Supply and Services, 1981. Single copies are available from the Manitoba Department of Education, Curriculum Services. Limited supplies are available.

6. Canadian Ministry of Transport. Road Safety Division. The Reasons Some People Have for Not Wearing a Seatbelt Could Prove Them Dead Wrong.

7. Manitoba Department of Highways and Transportation. Motor Vehicles Branch. Annual Report. Request most recent publication.

8. McCormack, A.J. "Egg Drop: An Invention Workshop." Source Activities, October, 1973, pp. 20-23.

9. Ontario Ministry of Transportation and Communications. System Research and Development Division. Safety Belt Use: A Mandate for Survival.

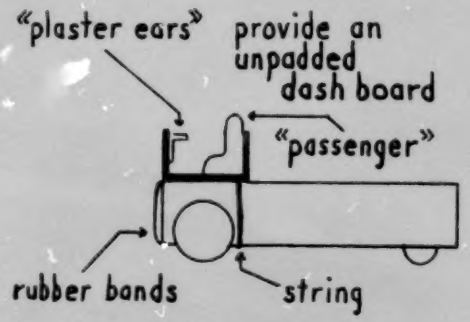
10. U.S. Department of Transportation. Automobile Passive Restraint Systems and What They Mean To You. Washington, D.C.: GPO, 1977. Available from the Allstate Insurance Companies of Canada, 255 Consumers Road, Willowdale, Ontario, M2J 1R4.

11. U.S. Department of Transportation. National Highway Traffic Safety Administration. The Case for Seat Belts: Experimental and Statistical Evidence. Washington, D.C.: GPO, 1973.

12. Wilde, G.J.S. Shoulder Belt Use Related To Sex, Age, Moving Speed and Weather Conditions: Studies of Safety in Transport. Kingston, Ont.: Queen's Univ. Press, 1977.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The students should be able to:		
1. Distinguish between first and second collisions in car accidents and identify the effects of each.	Have students examine photographs of wrecked cars to identify evidence of both first and second collisions. A field trip to an auto wrecking yard, an auto-body shop, or an Autopac claim centre might be arranged. A folder with a set of photos of a car that was involved in a serious accident, together with copies of the official police and Autopac reports of the accident, might be helpful.	ISIS - Packaging Passengers, Activity 2.
2. Describe how changes in speed and direction affect a car and its passengers. (State Newton's First and Second Laws of Motion and apply them to collisions between two objects of different masses).	Have students simulate automobile collisions using dynamics carts (from the Physics laboratory). To provide reproducible speeds, have them release the carts from a marked position on an inclined plane. Modeling clay cubes can be used to simulate the passengers or luggage. Have students ob-	ISIS - Packaging Passengers, Activity 3. The Human Collision. IME - Sections 8 and 9.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - quantifying - predicting - controlling variables - interpreting data and results	serve what happens to the simulated passengers during collisions with a stationary object and then relate the distance the cube is thrown to the cart's speed. Have students simulate collisions, this time varying the mass of the stopping object. Placing different weights in a shoe box is a convenient way of doing this. For each different mass, have the students measure the distance the stopping object is moved and the distance the simulated passenger is thrown.	ISIS - Packaging Passengers, Activity 3. PSIS - pp. 295-296.
3. Describe the safety features of a padded dashboard, a seat belt system, and an air bag system. Process involved: - experimenting	Have each student devise, make and test a package that will enable its contents (a fragile object such as an egg) to survive a 6-metre fall. Place restrictions on the size of the package (e.g., for an egg, no dimension may be more than 20 cm).	ISIS - Packaging Passengers, Activity 4. "Egg Drop: An Invention Workshop."
4. Describe when seat belts work best to reduce injuries to passengers in collisions. Processes involved: - observing	Have the students determine the effectiveness of padded dashboards, seat belts, and air bags in simulated collisions. First, have them fasten a metallic electric outlet box (with the sides removed) to a dynamics cart, as indicated on the following page:	ISIS - Packaging Passengers, Activity 5. NOTE: Other safety features such as collapsing steering wheels, controlled collapsing front ends, and shock absorbing bumpers have been developed and will be pro-

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
- interpreting data and results - predicting - experimenting	 A fairly large passenger can be made from modelling clay. For each collision listed below, carts should be released from the same starting position on the ramp (ensuring that they run at the same speed) and they should hit the same wall or immovable object. After each collision, have students record the damage to the passenger. Conditions 1. Passenger Unrestrained. 2. Padded Dash - Place a piece of split rubber tubing over the sharp edge of the "plaster ears." 3. Lap Belts - Fabricate a lap belt for the passenger using a)a thread, b) a shoelace, and c) a rubber band. Compare the effectiveness.	vided on newer cars. Various car magazines, as well as Popular Mechanics, often have feature articles related to car safety. IME - Section 9. Automobile Passive Restraint Systems and What They Mean to You.

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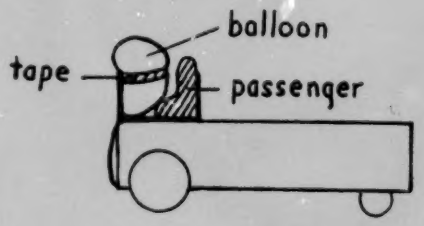
OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	4. 3-Point Belt - Use the most effective material (as determined on the previous page) to make a 3-point seat belt (lap and shoulder). 5. Air bag - Fill a balloon with a small amount of air and fasten it with a strip of masking tape to the front of the dash to ensure that the passenger does not fall out.  	
5. Compare the injuries of belted and unbelted passengers reported in graphs or tables. Process involved: - interpreting data and results	Have the students examine accident statistics describing injuries to belted and unbelted drivers.	ISIS - Packaging Passengers, Activity 6. The Human Collision. Motion and Collisions - Teacher's Document.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
6. Explain how effective air bags are in reducing injuries to passengers. Processes involved: - interpreting data and results - inferring	Provide descriptive information, diagrams, and/or photos to illustrate how an air bag restraining system works.	ISIS - Packaging Passengers, Activity 7.
7. a) Identify statements based on facts, not opinions, in the mandatory seat belt law debate; Processes involved: - classifying - inferring	Provide an opportunity for students to consider seriously whether Manitoba should pass a law making the wearing of seat belts compulsory. (Ontario and Saskatchewan already have such laws.) Class discussions, debates, panel discussions, etc., can help students to distinguish fact from opinion. The ISIS tape for Packaging Passengers provides several arguments for and against mandatory seat belt laws.	ISIS - Packaging Passengers, Activity 8. Motion and Collisions - Teacher's Document. The Case for Seat Belts: Experimental and Statistical Evidence. The Reasons Some People Have for Not Wearing a Seatbelt Could Prove Them Dead Wrong.
b) Explain the arguments for and against a seat belt law. Processes involved: - communicating - quantifying		

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
8. Identify ways that energy is conserved during car collisions. Process involved: - inferring	Provide descriptive information, diagrams, and/or photos to illustrate how the kinetic energy of a moving car is conserved in a collision. Emphasize that the energy is transformed from one form to another (mainly into heat) and that no energy is lost.	ISIS - Packaging Passengers, Activity 9. IME - Section 9.
9. Identify statements based on facts, not opinions, relative to safety design in automobiles. Processes involved: - classifying - inferring	Provide information about how automobiles have been made safer over the last ten years or so. The ISIS tape for Packaging Passengers provides a variety of facts and opinions about automobile safety. Help students distinguish fact from opinion.	ISIS - Packaging Passengers, Activity 15. SEE NOTE for objective 4. Motion and Collisions - Teacher's Document.
10. Describe safety features which have been developed for modern highways. Processes involved: - observing - inferring	Provide information about how highways have been made safer over the last ten years (such things as divided highways, improved guard rails, break-away poles, wider highways, and fog lines). Teachers who wish to emphasize the science society component might wish to introduce some of the following issues and questions:	ISIS - Packaging Passengers, Activity 16. Annual Report. Motion and Collisions - Teacher's Document.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	- Accident statistics indicate that young drivers have more accidents. Should the minimum driving age be increased from 16 to 18 or 21? - Some accidents are caused by mechanical malfunctions. Should every car have to have a safety check done every 6 or 12 months? (Most states in the U.S. require this.) - Small cars almost inevitably come out the losers in collisions with large cars. Since small, more fuel efficient cars are needed, should the sale of large cars be banned?	

CHEMICAL REACTIONS

Rationale:

This compulsory unit provides students with basic information about chemical reactions, atoms, and their ability to combine with one another.

Basic References:

1. Actions and Reactions. ISIS. Lexington, Mass.: Ginn, 1979.

2. Abraham, Norman, et al. Interaction of Matter and Energy: Inquiry in Physical Science (IME). 3rd ed. Chicago: Rand McNally, 1979.

Supplementary References:

1. Fire. ISIS. Lexington, Mass.: Ginn, 1977.

2. Hand, J.C., et al. Investigative Science: Chemistry Concepts. Toronto: MacMillan of Canada, 1978.

Audio-Visual Resources:

Films

1. "No Room for Error." This is a science safety film.

2. "Our Friend the Atom." This film is useful as an introduction to the unit.

3. "Chemical Families."

Available from the Department of Education.

Games:

Games for the Science Classroom

Write: Paul B. Hounshell
Ira R. Trollings
National Science Teachers' Association
1742 Connecticut Avenue, N.W.
Washington, D.C. 20009

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Describe the alchemist's theory of matter, why the theory is no longer accepted, and why theories may change or disappear over time. Process involved: - inferring	Have students observe and record physical properties of zinc and copper; then, have them observe the result change to brass) when a small piece of zinc is heated on top of a larger piece of copper in a hot flame. (A small quantity of ammonium chloride should be placed on top of the zinc; students should wear safety glasses while performing this activity.) At one time, people thought materials disappeared when new materials were produced. Alchemists tried to explain the production of new substances by using the idea of four elements (earth, air, fire, and water) whose appearances changed; thus more fire helped change zinc and copper to brass. Discuss why the theory is no longer accepted; e.g., some substances do not change when fire is added (no amount of heat will transmit lead into gold). The Phlogiston Theory can be used to explain how and why theories change.	ISIS - Fire. Activity 2 for Phlogiston Theory. IME - Sections 1 and 2. Film: "No Room for Error," "Our Friend the Atom." ISIS - Actions and Reactions, Activity 2.
2. Describe and apply Dalton's concept of atoms and elements.	Dalton's theory can be used to explain changes of zinc and copper to brass. Dalton's atomic theory states that:	ISIS - Actions and Reactions, Activity 3.

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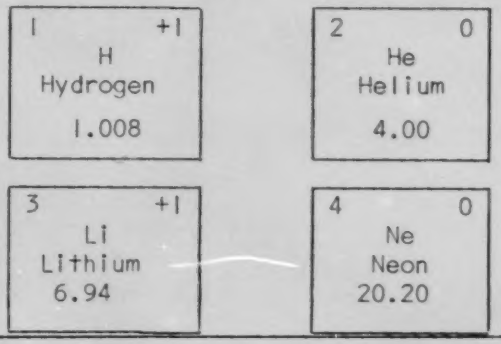
OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	a) matter consists of atoms which are very small, b) atoms are indestructible and unchangeable, c) atoms of the same element have the same shape, size and weight. Similarly, physical changes such as chalk to chalk dust can be explained.	
3. Use different models of atoms to predict the structure of the atom and the properties of the parts of the atom. Processes involved: - formulating models - interpreting data - inferring	Have students compare different models of atoms: Dalton's, rice pudding, Rutherford's. Because only indirect evidence is available, models of atoms are difficult to develop. Discuss how it can be determined whether objects exist in a box, given that the only access to that box consists of holes through which marbles can be rolled (black box). Relate this to Rutherford's experiments and to his new model of the atom, which has a small heavy nucleus (+ and n) and electrons outside the nucleus.	ISIS - Actions and Reactions, Activity 4. IME - Section 3.
4. Describe the differences between an atom and an ion. Processes involved: - interpreting data - formulating models	Demonstrate conductivity of solutions such as NaCl, sucrose, KBr and methyl alcohol, and pure water using electrodes and a milliammeter. Explain conductivity and non-conductivity on the basis of ions. An iron nail (or zinc) can be placed into a copper sulfate solution, resulting in the change of Cu^{+2} to Cu (neutral).	ISIS - Actions and Reactions, Activity 5. IME - Section 3.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
5. Describe the formation of an ionic bond and identify compounds that contain ionic bonds. Processes involved: - formulating models - inferring	Describe the formation of metallic and non-metallic bonds in terms of loss or gain of electrons and the formation of strong bonds. This can be related to families in the periodic table; e.g., refer to the alkali metals and their chemical activity in terms of loss of electrons. This can be related to their combining with non-metals such as chlorine.	ISIS - Actions and Reactions, Activity 6. IME - Section 5. Game: CHEM BINGO.
6. Describe the formation of a covalent bond and identify molecules with covalent bonds. Processes involved: - formulating models - inferring	Using diatomic molecules such as oxygen, fluorine or hydrogen, and molecules such as water or hydrogen chloride, discuss non-polar and polar covalent bonds in terms of equal sharing. This can be related to the periodic table in general terms of position on the left or right side of the table. Give students samples of combining atoms such as hydrogen and hydrogen, iodine and iodine, nitrogen and oxygen, and ask them to classify these in terms of polar or non-polar.	ISIS - Actions and Reactions, Activity 6. IME - Section 5.
7. Describe the difference between polar and non-polar covalent bonds, and identify molecules with each bond type.	Use Activity 6 to develop this idea.	ISIS - Actions and Reactions, Activity 6. IME - Section 10.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - formulating models - inferring		
8. Describe how a metallic bond is formed, and identify substances that contain metallic bonds. Processes involved: - formulating models - inferring	Describe metallic bonds in terms of their tendency to lose electrons. Metallic bonding can be related to the periodic table.	ISIS - Actions and Reactions, Activity 6.
9. Use a table of combining powers to derive the formula of a compound, once given the name, and to state the name, once given the formula. Processes involved: - formulating models - inferring	Describe the meaning of formulas such as H_2O; i.e., indicate the number and kinds of atoms. Relate this to the need to know combining powers and develop the use of combining powers in a formula; e.g., Cu^{+2} Cl^{-1}. Provide students with a table of simple combining powers and ask them to write the formulae of some compounds. Discuss the naming of simple "ide" and "ate" compounds. Provide some simple formulae (e.g., H Cl) and names of elements and have students name the compounds.	ISIS - Actions and Reactions, Activity 7. IME - Section 4. Games: CHEM CHEX; CHEM CUBES; CHEM RUMMY; CHEM TRAK; CHEMINOES; COMPOUNDS. Chemistry Concepts, "What is the Correct Combination?"

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
10. Explain the basis for the arrangement of elements in the modern periodic table. Processes involved: - classifying - inferring - observing	Students can determine similarities and differences among elements by experimentation (e.g., the reaction of metals and non-metals with different acids, water and an organic liquid). Refer to Actions and Reactions for safety instructions. Provide students with a deck of cards, each with an element's name and symbol, combining powers, atomic number and atomic weight (up to element 21). Have them set up the periodic table by placing elements with the same combining powers in vertical rows while keeping atomic numbers sequential horizontally. This will show more concretely the basis of the modern periodic table. 	ISIS - Actions and Reactions, Activity 8. IME - Section 4. Film: "Chemical Families."

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
11. Describe the factors used by Mendeleev in developing the classification of elements and infer how the classification proved useful in characterizing unknown elements. Processes involved: - classifying - inferring	After grouping elements, as illustrated by the card activity on the previous page, students should identify the basic factors used in grouping the elements; i.e., similarity of properties (combining power and other chemical behavior) and increasing atomic weight. Relate to Mendeleev's problems with the table (e.g., gaps).	ISIS - Actions and Reactions, Activity 8. CAUTION: The addition of nitric acid to copper produces nitrogen dioxide, a poisonous brown gas. This part of the activity should be done or demonstrated under a fume hood. IME - Section 4.
12. Use the periodic table to determine whether an element is a metal or non-metal. Process involved: - classifying	Provide students with a copy of a periodic table or have them use the periodic table in the room; then give them the names of elements and ask them to determine whether the elements are metallic, what their combining power or powers are, and whether they tend to lose or gain electrons.	ISIS - Actions and Reactions, Activity 8. IME - Section 4. Games: ELEMENTS; THE GAME OF ATOMS; ATOMIC SETBACK; ATOMIC SOLITAIRE; THE GREAT PERIODIC TABLE RACE.
13. Use the periodic table to determine the combining power(s) of an element and use combining powers to determine chemical formulas. Processes involved: - classifying	Refer to above activity.	ISIS - Actions and Reactions, Activity 9. IME - Section 4. Chemistry Concepts, "What is the Correct Combination?" and "The Name of the Game."

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
- inferring		
14. Use the periodic table to determine whether an element tends to lose or gain electrons. Processes involved: - classifying - inferring	Refer to Activity 12 on the previous page.	ISIS - Actions and Reactions, Activity 9. IME - Section 4.
15. Describe the characteristics of a chemical reaction and observe whether a chemical reaction has occurred. Processes involved: - observing - interpreting data	Demonstrate chemical reactions such as those resulting from burning magnesium ribbon or from placing copper foil in silver nitrate solution, and have observations recorded. Have students heat copper foil in a hot flame (CAUTION: tongs and safety glasses are required), and record results. Relate chemical reactions to energy loss or gain and to property changes; compare them to physical changes (e.g., cutting paper into small pieces). Students can be given a list of changes which they are to classify as physical or chemical.	ISIS - Actions and Reactions, Activity 10. IME - Section 5. Chemistry Concepts, "Elements in Action."
16. Write balanced equations for statements describing chemical reactions and identify reactants and	Describe the use of word equations, symbols, atoms and molecules, and combining powers in balancing equations. Provide some general rules	ISIS - Actions and Reactions, Activity 11. IME - Section 5. Chemistry Concepts, "The

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
products. Process involved: - classifying	such as: a) never change subscripts to balance equations; b) always adjust the co-efficients for formulae of compounds (never the subscripts within the formulae). Provide students with equations to be balanced.	Numbers Game" Games: CHEM CHEX, CHEM CUBES.
17. Describe what happens in terms of electron loss or gain in reduction and oxidation during a chemical reaction. Processes involved: - inferring - classifying - interpreting data	To infer that electrons are lost or gained in some chemical reactions, students can perform single experiments (e.g., dissolving zinc in copper sulfate solution), data of which can be used to relate color to the presence of ions and disappearance of solid metal to the formation of ions. The relationship of redox to other chemical reactions -- the burning of magnesium or hydrogen or the rusting of zinc or aluminum - can be described. There are practice exercises in ISIS, Actions and Reactions, for: (a) identifying different bond types, (b) writing formulas, (c) naming compounds, (d) using the periodic table to classify elements, (e) balancing equations.	ISIS - Actions and Reactions, Activity 12. IME - Section 5. Chemistry Concepts, "What's Your Reaction to This Activity?". Games: CHEM-E-Z; P & S.

CELLS

Rationale:

A study of normal and cancerous cells has academic and practical merit, both because of the public's general ignorance and neglect of their bodies and because of the high incidence of cancer. This compulsory unit compares the abnormal condition of cancer cells to the basic makeup and functioning of normal cells and tissues. It emphasizes ways to detect, prevent, and treat cancer.

Basic Reference:

1. Cells and Cancer. ISIS. Lexington, Mass.: Ginn, 1978.

Supplementary References:

1. Pamphlets from Canadian Cancer Society:

   - What is Cancer: Answers to Questions About Cancer
   - Youth Looks at Cancer
   - What Can You Do About Cancer: Cancer Facts for Men
   - Why Learn About Cancer: The Students Look at Cancer
   - Do Not Smoke #5
   - We Wish You Luck: You're Going to Need It
   - What About a Lump in the Breast: Breast Cancer
   - It Could Save Your Life: Breast Self-Examination
   - A Sane Look at Cancer: Cancer Facts for Women

2. Biological Science Curriculum Study. Biological Science: A Molecular Approach (BSCS Blue Version). 4th ed. Lexington, Mass.: D.C. Heath and Co., 1980.

Audio-Visual Resource:

1. "The Feminine Mistake." Available from the Canadian Cancer Society.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to:		
1. Identify the five main parts of a cell and describe their function. Process involved: - observing	Students can prepare cheek cell slides after reading about the cell as the building block of the body. The five important cell parts and their functions can be presented in various kinds of body cells.	ISIS - Cells and Cancer, Activities 2 and 13. BSCS Blue Version - Chapter 13.
2. Describe the characteristics of cancer cells and the methods by which they spread.	Students can answer questions related to the following topics: Cancer is the abnormal division of cells (too fast or more than two from a single division); benign tumors are different than malignant tumors; cancer grows and spreads via blood vessels or lymph nodes.	ISIS - Cells and Cancer, Activity 3.
3. Identify the seven warning signals of cancers and the type of cancer associated with each signal.	Discuss the Canadian Cancer Society's list of warning signals of cancer and the importance of learning these signals and seeing a doctor if a symptom persists for more than two weeks.	ISIS - Cells and Cancer, Activity 4.
4. a) Interpret a survival rate graph for cancer victims;		ISIS - Cells and Cancer, Activity 5. Canadian Cancer Society Pamphlets.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Identify three common methods of treating cancer and compare their effectiveness. Process involved: - interpreting data	Surgery, radiation, and chemotherapy are the most widely used treatments for cancer. The relative effectiveness of the three types of treatment can be discussed.	
5. Describe the causes, symptoms, diagnoses and treatments for the most common types of cancer.	Some of the symptoms, causes, diagnostic techniques, and treatments for different types of cancer can be learned by playing the DIAGNOSIS game or by referring to the Canadian Cancer Society pamphlets.	ISIS - Cells and Cancer, Activity 6.
6. Describe what body condition and actions of a person can increase the risk of developing cancer. Process involved: - predicting	Discuss some of the conditions that are related to incidence of cancer, the high risk conditions that can be controlled by the individual, and those that cannot.	ISIS - Cells and Cancer, Activity 7.
7. Identify and apply common diagnostic techniques for finding cancer. Processes involved: - observing	Students can take risk tests to determine their relative chances of getting cancer. They should be instructed in self-examination procedures and encouraged to perform these.	ISIS - Cells and Cancer, Activity 18. Pamphlets: What About a Lump in the Breast: Breast Cancer; It Could Save Your Life: Breast Self-Examination;

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
- predicting		A Sane Look at Cancer: Cancer Facts for Women.
8. a) Interpret a cancer death rate graph;	Students can use tables and graphs to gain information about trends in the frequencies of cancer occurrence and death.	ISIS - Cells and Cancer, Activity 8.
b) List which kinds of cancer correlate on increasing or decreasing death rates in males and females, giving possible reasons for these trends. Processes involved: - interpreting data - inferring		
9. Describe what is meant by probability statements that relate cigarette smoking to lung cancer. Process involved: - interpreting data	Percentages and statements of probability can sometimes be misleading. Students can be exposed to some probability statements containing percentages and determine what these statements do and do not mean.	ISIS - Cells and Cancer Activity 9. Pamphlets: Do Not Smoke #5 and We Wish You Luck: You're Going to Need It. Film: "The Feminine Mistake."
10. Describe the damaging side effects of cancer treatment	Discuss the undesirable side effects of cancer treatments (surgery, radia-	ISIS - Cells and Cancer, Activity 10.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
and explain why they occur.	tion, and chemotherapy) due to the harming of normal cells along with cancer cells. Discuss, too, the psychological side effects that also result and must be treated.	
11. Describe how the Curies and Becquerel contributed to cancer treatment and research.	Discuss how basic scientific research can lead to unanticipated discoveries; the work of Roentgen, Becquerel, and the Curies on X-rays led to the applied use of radiation as a treatment for cancer.	ISIS - Cells and Cancer, Activity 11.
12. a) Describe the cause of warts, moles, freckles, and sun tans, and their relationship to cancer; b) Recognize the difference between warts, moles and freckles. Processes involved: - observing - interpreting data	Discuss what causes skin extras (warts, moles and freckles), which can become cancerous, and what to do if a wart or mole changes. The relationship of sunburning and tanning to cancer can also be discussed.	ISIS - Cells and Cancer, Activity 17.
13. Describe the current status of cancer research and the outlook for finding the cause of cancer.	Discuss the different leads researchers are following in an effort to find a cure for cancer.	ISIS - Cells and Cancer, Activity 19.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Process involved: - interpreting data		

WAYS WE LEARN

Rationale:

Many students have poor study habits and very few know how to improve them. This compulsory unit gives the student a working knowledge of the principal factors that promote or prevent learning. It is intended to foster a positive attitude toward learning on the part of the students by introducing techniques designed to improve memory, study, and communication with others.

Basic Reference:

1. Ways We Learn. ISIS. Lexington, Mass.: Ginn, 1976.

Supplementary Materials:

1. Aptitude tests - See your guidance department.
2. Manual dexterity test - See your guidance department.
3. Employment and Immigration Canada. "CHOICES" - Inter-Active Computer Program. Available from the Canada Systems Group, Ottawa, Ontario. Teachers wishing to view a micro-version of the "CHOICES" program can contact Career Guidance and Counselling, Curriculum Services, Department of Education.

Audio-Visual Resources:

1. "Invention of the Adolescent"
2. "Child Behavior"
3. "Learning Through Inquiry"
4. "Invisible Handicap - Dyslexia"

Available from the Department of Education

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Identify the principal factors that motivate people's actions.		ISIS - Ways We Learn, Activity 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - observing - classifying		
2. Identify the principal factors that prevent learning. Process involved: - communicating	Students can view the film "Invention of the Adolescent" and discuss the various factors preventing learning.	ISIS - Ways We Learn, Activity 3. Film: "Invention of the Adolescent."
3. Identify the principal ways people learn skills. Process involved: - classifying	Have students use massed practice to learn a card trick and spaced practice to learn how to juggle. Use these activities to discuss factors affecting this kind of learning.	ISIS - Ways We Learn, Activity 4.
4. Describe the methods that are used to improve a person's memory and know the principal reasons a person remembers or forgets things. Processes involved: - communicating - classifying	Have students make up mnemonic devices to remember people's names. Have them find out what sort of things people tend to forget and remember.	ISIS - Ways We Learn, Activity 5.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
5. Identify how rules, formulas and laws are helpful in solving problems, and describe the four principal steps used to solve problems. Processes involved: - quantifying - classifying - formulating models	Have students solve some puzzles by finding a pattern.	ISIS - Ways We Learn, Activity 6.
6. Learn a new skill using proper learning techniques. Processes involved: - communicating - experimenting	Have students make a project out of learning how to do something which they have always wanted to do.	ISIS - Ways We Learn, Activity 7.
7. Establish what his or her own aptitude is: Process involved: - communicating	Have students take an aptitude test and examine the meaning of aptitudes.	ISIS - Ways We Learn, Activity 8. Aptitude tests. CHOICES.
8. Analyze the results of an aptitude test and correlate aptitudes to careers.	Teachers can give a manual dexterity test, and tabulate and graph the results. Percentile rank and most common score can be established.	ISIS - Ways We Learn, Activity 9. Manual dexterity test.

Sc. 101 - Ways We Learn

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - communicating - quantifying - inferring		
9. State how a behaviorist explains human learning, and describe the works of Pavlov and Skinner and their importance in the study of human learning; e.g., habits can be learned or extinguished by classical conditioning (paired stimuli) or by reinforcement of approximations of the desired behavior. Processes involved: - communicating - observing	Have the student ring a bell and, at the same time, blow air into another student's eye with a turkey-baster. After this has been done several times, the student should ring the bell without blowing the air. The conditioned response produced by this activity should be discussed.	ISIS - Ways We Learn, Activity 11. Film: "Child Behavior."
10. a) State how cognitive psychologists explain human learning;	Using a deck of playing cards, one student can attempt to get others to discover the category that he or she is thinking of (e.g., the category of face cards). The student shows the selected cards one at a time, asking how each card appears to repre-	ISIS - Ways We Learn, Activity 12. Film: "Learning Through Inquiry."

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	sent a category. The problem is solved when the students combine specific ideas to discover a general answer.	
b) Describe the works of Ausubel and Bruner and the importance of these works in the study of human learning. Processes involved: - classifying - communicating	One student can read a list of ten numerals to a subject --another student-- at a rate of one every three seconds and then at a rate of one every half second. The ability of the subject to recall the numbers using long and short term memory can be compared.	
11. Describe how physical handicaps such as blindness affect learning and how people adjust by improving other feedback systems. Processes involved: - inferring - classifying	A blindfolded student can attempt to build an unfamiliar device on the basis of verbal instructions alone.	ISIS - Ways We Learn, Activity 14. Film: "Invisible Handicap - Dyslexia."
12. Describe the effect of practice on learning and on how much is forgotten between learning sessions.	Have students take a test in some rote memory items such as chemical symbols or morse code. Retest them after practice sessions and after a forgetting period (with and without practice	ISIS - Ways We Learn, Activity 15.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - interpreting - communicating - quantifying	sessions).	

FOSSIL FUELS

Rationale:

In an era with a so-called energy "crisis," there is a need to begin examining the important role of fossil fuels in society. This option unit deals with the origins of fossil fuels within the earth and the ways they are processed and used. It focuses on potential reasons for limited supplies of fossil fuels, on the environmental effects of obtaining them, on the products and pollutants formed by burning them, on petroleum refinement and on choices among available fuels. Since some of the data in basic references is American, a document containing Canadian data, Fossil Fuels, will be available from Curriculum Services in 1982.

Basic Reference:

1. Fossil Fuels. ISIS. Lexington, Mass.: Ginn, 1980.

Supplementary References:

Some of the materials listed below should be screened very carefully for bias and used with discretion. Since some of the data will change over a period of time, information will have to be up-dated on a regular basis.

1. Manitoba Department of Education. Fossil Fuels. Teacher's Document, 1982.

2. Tracy, George R., et al. Modern Physical Science. New York: Holt, Rinehart and Winston, 1979.

3. Smallwood, William, and Carl Brown. Challenges to Science: General Science for Tomorrow's World. New York: McGraw-Hill, 1980.

4. Canadian Department of Energy, Mines and Resources.

   - Energy Management for the Future
   - Coal Resources and Reserves of Canada
   - Coal in Canada
   - Renewable Energy Resources: A Guide to the Future
   - Energy Update (1981)
   - The National Energy Program

   Available from Energy, Mines and Resources, 580 Booth Street, Ottawa, Ontario.

5. Manitoba Environmental Council. The Energy Issue: Demand and Supply. Study 9. Winnipeg: Manitoba Environmental Council, 1977.

6. The Petroleum Resources Communication Foundation. Our Petroleum Challenge: The New Era; Great Canadian Energy Quiz. Available from the Petroleum

Resources Communication Foundation, #105-309 2nd Avenue, S.W., Calgary, Alberta.

7. Coal in Canada. Available from the Coal Association of Canada, Suite 590, Three Calgary Place, 355-4th Avenue, S.W., Calgary, Alberta.

8. Oil and Gas: Their Origin, Production and Use. 1979. Available from Imperial Oil Ltd.

9. Canadian Petroleum Association. Focus on Energy Series:

   - A Brief History of the Petroleum Industry in Canada
   - The Origins of Oil and Gas
   - The Search, Exploration, Drilling and Production
   - Transportation
   - Refining, Distribution and Marketing
   - Frontier Oil and Gas, Oil Sands and Heavy Oil

   Available from the Public Affairs Department, Canadian Petroleum Association, 1500, 633-6th Avenue, S.W., Calgary, Alberta.

10. Shell Canada. Briefing Papers:

   - World Oil and Gas in 1979
   - Protecting the Environment
   - Oil Products in Canada
   - Transportation Fuels Outlook
   - Perspective on Oil Spills
   - Alsands Project Group
   - St. Boniface Refinery
   - Canada's Oil and Gas Reserves
   - Developing the Tar Sands

   Available from Shell Information Services, P.O. Box 400, Toronto, Ontario.

11. National Energy Board. Canadian Oil: Supply and Requirements. September, 1978. Available from the Canadian Energy Board, 473 Albert Street, Ottawa, Ontario.

12. National Energy Board. Canadian Natural Gas: Supply and Requirements. February, 1979. Available from the Canadian Energy Board, 473 Albert Street, Ottawa, Ontario.

13. Canada As a Consumer Society: An Agenda for Action, 1978. Available from the Publications Office, Science Council of Canada, 150 Kent Street, Ottawa, Ontario.

14. Ashcroft, Ken, and Joe Hamill. Chemistry of the Car. Agincourt, Ont.: Book Society of Canada, 1980. Advanced material to be used with caution. Some activities should not be attempted or attempted only with great care.

Audio-Visual Resources:

1. -Oil Well

   -Oil in Depth: No. 13

   -Refinery Processes

   -This Land

   -Oil Spill: A Progress Report

   Available from the Film Library, Shell Canada Limited, 136 Edward Street, Toronto, Ontario.

2. Our Petroluem Challenge:

   Tape 3a - History of Petroluem,
   - Technology of Drilling,
   - Rigging Up;

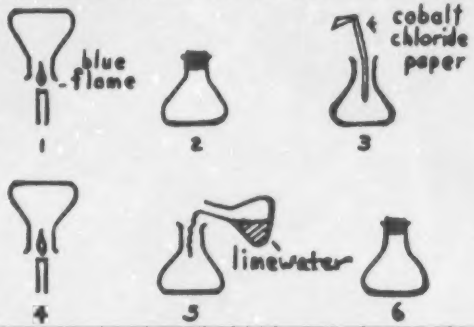
   Tape 3b - Crude Oil,
   - Natural Gas,
   - Tar Sands.

3. Tar Sands: A Dream Come True (Parts I and II).

4. Shell Canada - The Coal Option.

The materials above (references 2, 3, and 4) are available as video-cassettes. Copies can be made at Instructional Media Services, Department of Education, if blank tapes are sent.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should able to: 1. Describe how fossil fuels may have been formed and why the supply is limited.	Diagrams illustrating coal or oil formation can be used in order to develop theories of fossil fuel development.	ISIS - Fossil Fuels, Activity 2. Coal in Canada. General Science for Tomorrow's World (Chapter 4). The Origins of Oil and Gas. Fossil Fuels - Teacher's Document. Videotape: The Coal Option.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
2. Describe the processes of distillation and catalytic cracking in the development of useful fractions from crude oil. Processes involved: - observing - inferring	Have students distill and collect fractions of an isopropyl alcohol-water mixture, and compare this to the more elaborate refinery process of fractionally distilling crude oil and catalytic cracking. Demonstration: Heat paraffin with an aluminum powder catalyst to produce a gaseous hydrocarbon from a long-chain liquid hydrocarbon to demonstrate the cracking process or to describe fractions. CAUTION. Discuss cracking and define the role of a catalyst. (See reference.)	ISIS - Fossil Fuels, Activity 3. General Science for Tomorrow's World (Chapter 4). Modern Physical Science (Chapter 12). Oil and Gas: Their Origin, Production and Use.
3. a) Identify water and carbon dioxide as major products of burning fossil fuels and identify other products;	With the use of limewater and cobalt chloride test paper, the products of burning natural gas can be identified as water and carbon dioxide.  	ISIS - Fossil Fuels, Activity 4. Modern Physical Science (Chapter 12).

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Identify carbon as a product of burning fossil fuels in an oxygen deficient environment;	Above a candle or a burner that is set to produce a yellow flame, a piece of aluminum foil can be held. It will soon darken from the carbon particles collecting on it. The activity shows that carbon particles are produced when certain materials like wax or substances like natural gas burn in an oxygen deficient environment. $C H_4$ (methane) + 2 O_2 (oxygen) --> CO_2 (carbon dioxide) + 2 H_2O (water)	
c) Describe the chemical reactions that occur during the burning of short-chain fossil fuels (e.g., methane). Processes involved: - observing - inferring	Refer to above activity.	
4. Describe how chemicals control burning rate, how octane numbers and gasolines differ, and how these differences relate to evenness of burning.	Two pieces of paper can be cut and laid on a fireproof pad after one has been soaked in a borax solution. The papers can then be left to dry before being lit with a match. The borax treated paper burns slowly and evenly (CAUTION: Fumes).	ISIS - Fossil Fuels, Activity 5. Fossil Fuels - Teacher's Document. General Science for Tomorrow's World (Chapter 16 - "Automobile Power").

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	Describe the burning of gasoline in a gasoline engine. Have students examine models of straight chain and branched octane molecules (straight chain hydrocarbons burn faster), and the relationship of octane rating to burning.	
5. Describe how pollutants from car exhausts can be reduced by catalytic converters.	Survey the various pollutants from car exhausts and study how catalytic converters reduce them.	ISIS - Fossil Fuels, Activity 5. General Science for Tomorrow's World (Chapter 16 - "Automobile Power"). Fossil Fuels - Teacher's Document.
6. a) Describe how recent trends in North America's use of fossil fuels compare with trends in world use;	Compare the production and consumption of various fossil fuels in Canada over the past 25 years to their supply.	ISIS - Fossil Fuels, Activity 6. U.S.-orientated data may be replaced with data from Fossil Fuels - Teacher's Document. Our Petroleum Challenge: The New Era. Coal Resources and Reserves of Canada. Shell Briefing Papers - Canada's Oil and Gas Reserves and Developing the Tar Sands.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Identify the most abundant and least abundant fossil fuels. Processes involved: - inferring - interpreting data		
7. Describe the environmental effects of extracting and transporting fossil fuels.	Discuss methods of extracting and transporting coal and oil. Examples of good environmental management can be contrasted to strip mining and oil spills.	ISIS - Fossil Fuels, Activities 7 and 16. Coal in Canada. Shell Briefing Papers - Protecting the Environment and Perspective on Oil Spills. General Science for Tomorrow's World (Chapter 5). Videotapes: Tape 3b; Tar Sands: A Dream Come True; The Coal Option.
8. Describe how energy can be converted from one form to another and show how energy is conserved in the process; describe how useful energy can be lost during conversion.	Students can make a steam generator run a simple turbine (miniature generator) to produce a small electrical current. By experimenting with the apparatus, they can see that some useful energy is lost in the conversion process.	ISIS - Fossil Fuels, Activity 9. General Science for Tomorrow's World (Chapter 2).

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - observing - inferring		
9. Describe the pros and cons of using coal rather than oil or natural gas in terms of availability, environmental effects and efficiency.	Students can try by various methods--scraper, cotton ball, sand, detergent, rolled cloth -- to clean pans of crude oil. All methods have faults, but students can decide which appears to be the best.	ISIS - Fossil Fuels, Activity 9. Refer to objective 7. The Coal Option or Renewable Energy Resources: A Guide to the Future.
10. Describe the production of fuels from wastes. Processes involved: - observing - inferring	A flammable gas can be produced by heating dried grapefruit peel, small pieces of wood splint and waste paper (garbage) in the process called pyrolysis. The mixture is heated in a test tube connected to a glass tube assembly for ignition.	ISIS - Fossil Fuels, Activity 10. General Science for Tomorrow's World (Chapter 8).

KNOW YOUR CAR

Rationale:

This option unit relates some physical science principles to basic automobile systems such as ignition, cooling, duel-carburetion, and lubrication. It should provide sufficient scientific and practical background knowledge so that students can better adjust to and prevent simple problems in the operation of the automobile.

Basic Reference:

1. Know Your Car. ISIS. Lexington, Mass.: Ginn, 1980.

Supplementary References:

1. Energy, Mines and Resources Canada. The Car Mileage Book. Ottawa, EMR, 1977.
2. Shell Canada. Shell Helps Series. Books 1-13. Available from the local Shell dealer, or by writing:
   "Shell Helps,"
   P.O. Box 7092,
   Adelaide Street Post Office,
   Toronto, Ontario, M5C 2K7.
3. Transport Canada. Fuel Consumption Guide. Ottawa: Updated yearly.
4. Conway, Arthur. Engines. Macdonald Introduction to Technology. London: Macdonald Educational, 1975.

Audio-Visual Resource:

1. The Engines. Shell Canada Limited. This film uses a cutaway model to illustrate the operations of a 4-cycle engine and includes a discussion of the cycles, ignition and carburetion, and an introduction to fuel injection.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Describe the electrical system in an automobile:		Note: It is sometimes possible to make arrangements

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
		with an auto mechanics instructor or a local garageman to have a demonstration or a cutaway engine in your class for a short time.
a) Describe a complete circuit;	The student can read about, assemble, and test a direct circuit.	
b) Explain the structure and function of a car battery;	The student can construct a simple lead storage battery.	Film: The Engines. (This could be used as a general introduction to all aspects of the operation of an automobile engine.)
c) Explain the care and charging of a battery as well as the clues that indicate a battery is about to fail; Processes involved: - observing - inferring	The student can vary the fluid level and the charging time of the battery and observe the effect on the length of time the battery will light a light bulb. (CAUTION: Charging the battery produces explosive gases.)	ISIS - Know Your Car, Activities 2-4. (The activities support all of objective 1, a-f.) Shell Helps Series - "The Car Breakdown Book" (No. 1). The Car Mileage Book. Engines (Spark Ignition).
d) Explain the function of spark plugs and the type of defects that cause spark plug failure; Processes involved: - observing		

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
- inferring e) Explain the function of the coil, points, and capacitor in an ignition system; test for spark production; discern the differences among common types of ignition systems; f) Explain the function of the distributor and the importance of setting the timing. 2. Describe how liquid cooling systems work in an automobile:		ISIS - Know Your Car, Activity 5. Engines (Cooling). Shell Helps Series - "The Longer Car Life Book" and "The Early Warning Book". The Car Mileage Book (see the section on the Cooling System, pp. 59-60 and 73).
a) Describe the common causes of overheating, the methods of circulating fluid, and the reason antifreeze may be used in all climates; b) State reasons for pressurizing liquid cooling systems	The boiling point of pure water and of antifreeze-water solutions can be measured.	

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
and describe the function of an overflow reservoir;	Students can fill a container with water, place an overflow tube in it, close it, and lead the overflow hose to an empty beaker. The container can be heated and observed, then cooled and observed.	
c) Describe the thermostat in terms of feedback control.	A thermostat can be placed in a container of water to be heated. The temperature can be measured at regular intervals and the thermostat observed.	
3. Describe the functions of the parts of a fuel system:		ISIS - Know Your Car, Activity 6. The Car Mileage Book (Fuel Systems - p. 70). Engines (Feeding Petrol and Air).
a) Explain the functioning of a carburetor on the basis of scientific principles;	The student can use a drinking straw and an eyedropper to demonstrate how a carburetor mixes fuel and air.	
b) Describe the causes of some common troubles with an ordinary carburetor system.	Service station operators sometimes donate old carburetors to classrooms. This allows students to observe an actual carburetor as they read about the various parts.	
4. Describe the function of lubricants and factors to consider in their selection.	The student can measure the force required to turn a shaft on a "bearing" with and without oil.	ISIS - Know Your Car, Activity 7. Shell Helps Series - "The

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
		Longer Car Life Book".
5. Define the effect of tire pressure on traction, tread wear, safety, fuel economy, and riding comfort:		ISIS - Know Your Car, Activity 8. The Car Mileage Book, p. 68. Shell Helps Series - "The Car Myths" and "The Gasoline Economy Book".
a) Define pressure in pascals and calculate pressure when force and surface area are provided;		
b) Relate the force exerted by an automobile to tire pressure;		
c) Explain how underinflation and overinflation affect tire wear, traction, comfort and fuel economy.		
Process involved:		
- quantifying		
6.		
a) Describe the products of complete and incomplete combustion;	Students can burn a hydrocarbon (wax) to demonstrate the products of combustion.	ISIS - Know Your Car, Activity 15. The Car Mileage Book.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Relate the effect of catalytic converters to the kinds of pollutants produced and the nature of gasolines required. Processes involved: - observing - inferring		
7. Compare automobiles in terms of engine displacement, power and compression ratio.		ISIS - Know Your Car, Activity 16. The Car Mileage Book. Fuel Consumption Guide.

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NUTRITION

Rationale:

Since many people overeat and underexercise, information on what food is and how it can be used to produce a healthy body is important to the individual. In this option unit, students learn what to eat for both weight control and good nutrition. They check their own diets and plan a program of diet and exercise. The approach is generally positive toward the problem of obesity and overweight.

Basic Reference:

1. Let's Eat. ISIS. Lexington, Mass.: Ginn, 1977.

Supplementary References:

1. Ontario Milk Marketing Board. Energetics: Balancing Food Intake with Energy Output. Available free of charge from the Manitoba Milk Producer's Marketing Board, 104-1580 Dublin Avenue, Winnipeg, Manitoba. NOTE: This package can be obtained only after having taken part in a one-day in-service dealing with the "Energetics" materials. In-services are available on request. Contact the Manitoba Milk Producer's Marketing Board, telephone 786-6063.
2. Australian Science Education Project (ASEP). Foods. Melbourne: GP, 1974. Available from Prentice-Hall of Australia.
3. Robertson, E.C. The Right Combination: A Guide to Food and Nutrition. 2nd ed. Toronto: Gage Educational Publishing, 1980.
4. Health and Welfare Canada. Health Services and Promotion Branch. Nutrient Value of Some Common Foods. Available from the Department of Health and Community Services, 880 Portage Avenue, Winnipeg, Manitoba.
5. Manitoba Department of Education. Computer Services Branch "DIET C" - Computer Program. Available free of charge from the Deparment of Education, 1181 Portage Avenue, Winnipeg, Manitoba. A three- to seven-day tabulation of food intake is analyzed by computer, giving the student a complete diet analysis according to Canadian Nutritional Standards.

Audio-Visual Resource:

1. "The Whole Body Manual." Available from the Home Economics Resource Centre, 212-880 Portage Avenue, Winnipeg, Manitoba, R3G OP1.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. a) List the three major nutrient food groups; b) Describe why the body needs the three nutrient food groups; c) List the four major food groups as specified by the Canada Food Guide; d) Identify the correct food group for a given food; e) Infer the presence of water and carbon in certain foods as a result of heating. Processes involved: - observing - interpreting data - classifying	Leaves from plants (celery, lettuce) can be heated to show that they are mostly water and carbon. Sugar can be heated in a foil cup to show that carbon is its principle constituent and that heat is produced as sugar burns.	ISIS - Let's Eat, Activity 2. ASEP - Foods - Core. Film: "The Whole Body Manual." The Right Combination, Section 1, Chapters 1, 3, 4, 5, 6. Energetics, "Food Classification."

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
2. a) Classify the foods eaten in various categories for a single day's food consumption; b) Interpret data accumulated to write out a food intake score. Processes involved: - quantifying - communicating	The student can keep a record of daily food intake. Or if a computer terminal is available the "DIET C" program can be used; a three- to seven-day tabulation of food intake is analyzed by computer, giving the student a complete diet analysis according to Canadian Nutritional Standards.	ISIS - Let's Eat, Activity 3. The Right Combination, Section, Chapter 3. Nutrient Value of Some Common Foods. Computer Program: "DIET C".
3. a) Determine whether or not he or she is eating a balanced diet; b) Express what is meant by minimal daily allowances.	The student can list the nutrients which make up a balanced diet in order to determine the degree of balance in his/her diet. The computer printout (Activity 2) can be used to further assess the degree of balance in the student's diet.	ISIS - Let's Eat, Activity 4. ASEP - Foods, Option 5. The Right Combination, Section 3, Chapter 3.
4. a) Define operationally a food calorie, joule, and kilojoule;	Water can be heated to introduce the concept of the calorie.	ISIS - Let's Eat, Activity 5. ASEP - Foods, Option 5. The Right Combination, Section 1, Chapter 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Interpret calorie data charts to calculate total calories used in a typical day; c) Explain why a certain amount of food calories are needed to maintain the body; d) Identify high and low calorie foods. Processes involved: - predicting - inferring - observing - interpreting data - quantifying - communicating	The number of food calories eaten in a day can be calculated by comparing daily food intake to calorie chart information.	
5. a) Make simple measurements of skinfold thickness; b) Interpret data about age and skinfold thickness;	Skinfold thickness can be measured to determine generally excessive weight.	ISIS - Let's Eat, Activity 6. ASEP - Foods, Option 6. The Right Combination, Section 3, Chapter 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
c) Describe three health hazards of being overweight and two hazards of crash diets. Processes involved: - observing - quantifying - interpreting data - predicting		
6. a) Explain why a sound weight control plan should involve proper nutrition and exercise; b) Calculate basal metabolic rate. Processes involved: - predicting - quantifying	The student can answer questions related to diet and exercise in terms of calories used in physical activities and calorie intake from foods eaten.	ISIS - Let's Eat, Activity 7. ASEP - Foods, Options 2 and 6. Energetics, "Food Selection and Physical Activity."
7. a) Explain the importance of vitamins and minerals in a balanced diet;	Students can identify good food sources for vitamins and minerals and describe the advantages and disadvantages of taking vitamin and mineral food supplements.	ISIS - Let's Eat, Activity 8. The Right Combination, Section 1, Chapters 7 and 8.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Identify symptoms of vitamin and mineral deficiency. Process involved: - inferring		
8. Describe some successful techniques for preventing overeating.	Discuss external influences affecting overeating and mechanisms of control.	ISIS - Let's Eat, Activity 12. ASEP - Foods, Option 6. Energetics, "Eating Behavior."
9. a) Explain how tooth decay happens; b) Describe ways of reducing tooth decay.	Students can read about and answer questions related to food and tooth decay.	ISIS - Let's Eat, Activity 9.
10. a) Explain the major differences in food quantity and quality between developed and undeveloped countries; b) Interpret data related to world food production.	Students can compare the amount of food per person and the quality of the diets in developed countries with those in developing countries..	ISIS - Let's Eat, Activity 10.
11. a) Describe the role of technology in improving the kind	Students can read and answer questions related to technology and its role in	ISIS - Let's Eat, Activity 11.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
and quality of food in Canada;	improving the kind and quality of food. Information related to Canada is required and may be obtained from either the Provincial or Federal Departments of Agriculture.	
b) Outline some problems associated with the use of pesticides and fertilizers.		
12. Interpret information found on nutrition labels on packages.	Nutrient information is given on labelling. The student can answer questions related to labelling and the consumer.	ISIS - Let's Eat, Activity 17 (note that Canadian regulations are different). The Right Combination, Section 3, Chapter 3.
13. Test foods for the presence of starches, sugar, fats and protein. Processes involved: - observing - quantifying	Students can perform tests for fats, proteins and carbohydrates in the laboratory to suggest a perfect food--milk.	ISIS - Let's Eat, Activity 18. ASEP - Foods, Core, Option 1.
14. Use accepted guidelines for evaluating the effectiveness and suitability of common diet plans.		Energetics, "Diet Analysis"

FOOD AND MICROORGANISMS

Rationale:

It is important to understand the role that bacteria, molds, and yeast play in the preparation and preservation of the food, both animal and plant, that people eat. This option unit focuses on the characteristics of several common groups of microorganisms and their effects on people and their food. The growth and reproduction of bacteria, molds, and yeast are investigated.

Basic Reference:

1. Food and Microorganisms. ISIS. Lexington, Mass.: Ginn, 1976.

Supplementary References:

1. Australian Science Education Project (ASEP). Microbes. Prentice-Hall of Australia, 1979.
2. Health and Welfare. Health Protection and Food Laws. Ottawa: The Minister of National Health and Welfare, 1979.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to:		
1. Control certain variables in preparing microogranism cultures. Processes involved: - observing - classifying - recording data	Students can prepare cultures of microorganisms on a variety of foods in cool and warm conditions; they can observe the daily growth and record data. (CAUTION needed when handling cultures.)	ISIS - Food and Microorganisms, Activity 2. ASEP - Microbes, Activity 1.
2. Identify some common microorganisms without the aid of a microscope.	Students can identify bacteria, yeasts, and molds by observing cultures grown on food.	ISIS - Food and Microorganisms, Activity 3.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - observing - classifying		
3. Describe the importance of bacteria in the nitrogen cycle.	Students can read about how bacteria recycle nitrogen and nitrogen compounds in the natural environment.	ISIS - Food and Microorganisms, Activity 4.
4. Demonstrate the preserving of foods by preventing the growth of microorganisms on them through drying, lowering pH, increasing or decreasing temperature, and canning. Process involved: - inferring	Students can air-dry apples using the sun; dry slices of potato by drawing out their water content by using salt and sugar; preserve cucumber pickles by using vinegar (an acid); observe mold growth at various temperatures; or preserve peaches by canning. Refer to Home Economics teachers for aid.	ISIS - Food and Microorganisms, Activities 5, 6, 9, and 17. ASEP - Microbes, Option 4, Activities 1, 2, 3. Health Protection and Food Laws.
5. Identify arguments for and against the use of food additives.		ISIS - Food and Microorganisms, Activity 7.
6. Describe the causes and symptoms of food poisoning. Process involved: - inferring	Have students read about the causes and symptoms of major types of food poisoning, as well as about the foods most often involved. Have them learn techniques of handling food to avoid contamination.	ISIS - Food and Microorganisms, Activities 8 and 11.
7. Describe how microorganisms can aid in food and beverage making.	Have students make apple cider and bread. Refer to Home Economics teachers for aid.	ISIS - Food and Microorganisms, Activity 10. ASEP - Microbes, Activity 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Process involved: - inferring		
8. State the conditions required for microorganisms to grow.	Students can grow yeast in water with dissolved sugar and without dissolved sugar, and identify the end products. They can read about the steps in aerobic respiration. Students can also grow staphlococci bacteria by innoculating agar plates with fingertips after washing with water, soap and water, antiseptic, etc. (CAUTION with cultures.)	ISIS - Food and Microorganisms, Activities 13 and 14.

HOUSEHOLD ENERGY

Rationale:

The world is running low on fossil fuels such as oil and natural gas. At the same time, more people are demanding more energy for their homes. This option unit will give the student a general awareness of the cost of energy, the efficiency of various energy sources, and methods for conserving energy in the home.

Basic Reference:

1. Household Energy. ISIS. Lexington, Mass.: Ginn, 1976.

Supplementary References:

1. Abraham, Norman, et al. Interaction of Matter and Energy: Inquiry in Physical Science.(IME), 3rd ed. Chicago: Rand McNally, 1979.
2. Energy, Mines and Resources. 100 Ways to Save Money and Energy in the Home. Ottawa: EMR, 1980.
3. Manitoba Hydro. Insulation: The Effective Use of Electricity. Available from the Manitoba Hydro, Energy Communications, P.O. Box 815, Winnipeg, Manitoba, R3C 2P4.

Audio-Visual Resources:

1. Bill Loosely's Heat Pump.
2. Energy Dilemma.
3. Electricity - How It Is Generated.
4. Energy for the Future.

All films listed above are available from the Department of Education Library.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Describe the various sources of energy for the home and their cost.	To obtain current rates or costs, various utilities can be contacted. Energy costs for various electrical appliances can be calculated.	ISIS - Household Energy, Activity 2.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
2. Compare the power used by common household appliances. Process involved: - observing	Students can assemble a circuit with a single bulb, ammeter, and voltmeter, and calculate the power used by the bulb.	ISIS - Household Energy, Activity 3.
3. Compare the cost of various forms of energy. Processes involved: - observing - classifying	A common standard, such as kilowatts, can be used to compare the heating costs of different energy sources.	ISIS - Household Energy, Activites 4-6. Monthly Hydro Rates - Manitoba Hydro. Latest prices from local fuel oil, natural gas, coal and wood dealers. 100 Ways to Save Money and Energy in the Home - pp. 97-108.
4. a) Describe the operation of heating and cooling systems and compare their efficiency and cost; Process involved: - observing	A bimetal strip can be heated with a match and then cooled. The strip can be used to control a circuit.	ISIS - Household Energy, Activities 7-8.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
b) Describe how human comfort and energy consumption are related.		
5. a) Measure the effectiveness of an insulating material in slowing heat flow; Processes involved: - observing - inferring	Have students measure the rate of heat loss from a beaker of hot water that is first uninsulated and then insulated. Have them put cool water in a glass, styrofoam, and tin cup, put all three in a tray of hot water, and compare their temperatures after one minute.	ISIS - Household Energy, Activity 9. Insulation: The Effective Use of Electricity. 100 Ways to Save Money and Energy in the Home. IME - Investigations 11.1, 11.6.
b) Describe the benefits of insulating a house.		
6. Describe the greenhouse effect and its advantages for home heating. Process involved: - observing	A thermometer placed between two sheets of aluminum foil can be put in direct sunlight. This experiment can be repeated using soot blackened foil. Have students compare the heat absorbed by the shiny foil to that absorbed by the blackened foil. A concave mirror can be used to focus sunlight onto the bulb of a thermometer. Have students design their own experiment using two sytrofoam cups, two thermometers, and a piece of plastic wrap	ISIS - Household Energy, Activity 16. IME - Investigations 13.3.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	to demonstrate the greenhouse effect.	
7. Observe and describe methods for conserving energy. Processes involved: - observing - quantifying - inferring	Have students find the time required to bring a pan of cold water to a boil on a 15 cm stove element and on a 20 cm stove element. Have them calculate the energy used in each case and compare.	ISIS - Household Energy, Activities 17 and 18. IME - Investigation 11.2.

FIRE

Rationale:

Students are provided with information and laboratory activities which will enable them to understand the principles of combustion and its control. Factors affecting safety in fires and safe procedures in the home are examined. Processes supported in this option unit include classification, inference, modeling, and the design of an experiment.

Basic Reference:

1. Fire. ISIS. Lexington, Mass.: Ginn, 1977.

Supplementary References:

1. Blackledge, J., D. Carter and J.J. Milbourn. Nuffield Secondary Science: Using Materials. London: Longman Group. 1971.

2. Brown, W.R., and N.D. Anderson. Physical Science: A Search for Understanding. Philadelphia: J.B. Lippincott, 1972.

3. Consumer and Corporate Affairs Canada (pamphlets)

   - Carelessness and Fabric Fires
   - Facts Relating to Textile Flammability
   - Hazardous Product Act (July 27, 1976)

4. Office of the Fire Commissioner (pamphlets)

   - A Fire-Safe Holiday
   - Apartment and Condominium Fire Safety
   - Babysitter's Handbook
   - Clothing Can Burn
   - Don't Let Your Family Burn
   - Early Fire Detection in Residential Buildings
   - Exit
   - Fire
   - Fire Escape for Office Workers
   - Fire Prevention All Over Your Home
   - Fire Safety for You: A Guide for Handicapped People
   - Fire Safety in the Home
   - In a Fire, Seconds Count
   - Mobile Home Fire Check
   - The Old Lady

- This is Your New ABCD's of Portable Fire Extinguishers

  Available from the Office of the Fire Commissioner, 610 Norquay Bldg., 401 York Ave., Winnipeg, Manitoba.

5. Portage la Prairie Mutual Insurance Co. Don't Lose Lives Saving Energy.

6. Ramsey, W.L., L.A. Gabriel, J.F. McGuirk, C.R. Phillips, and F.M. Watenpaugh. Holt Physical Science. New York: Holt, Rhinehart and Winston, 1982.

7. Shell Canada. Shell Helps Series. "The Fire Safety Book." No. 14. (pamphlet in a series). Available from the Local Shell dealer, or by writing: "Shell Helps," Box 7092, Toronto, Ontario, M5C 2K7.

8. Tracy, G.R., H.E. Tropp, and A.E. Friedl. Modern Physical Science. New York: Holt, Rinehart and Winston, 1979.

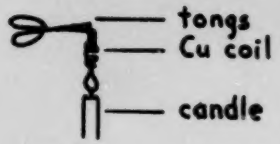
Audio-Visual Resource:

1. "The ABCD's of Portable Fire Extinguishers."

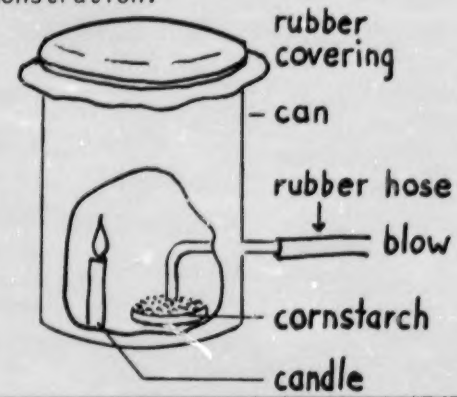
   Available from the Office of the Fire Commissioner.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Apply the Law of Conservation of Mass to a comparison of the modern theory of combustion and the phlogiston theory. Processes involved: - observing and inferring (distinguishing between) - interpreting data - comparing models	Have students observe a burning match to determine whether materials appear to be given off. Discuss closed and open systems (e.g., the earth and its atmosphere is essentially a closed system, except for solar energy). A candle on an asbestos pad can be lighted and an inverted beaker placed over it. Students can explain their observations using the phlogiston theory.	ISIS - Fire, Activity 2

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	The candle and pad can be placed on a balance pan and balanced. The candle can be lighted, allowed to burn for two or three minutes, and then rebalanced. The weight differences can be explained in terms of the phlogiston theory. Steel wool and a pad can be placed on a balance pan and balanced with weights. The steel wool can be lighted and then re-balanced. Students can try to explain their observations on the basis of the phlogiston theory, which can introduce discussion of the need for a new theory of burning. A flash bulb can be balanced on a pan balance, before being removed and used in a camera. Once cooled, it can be placed back on the balance and weighed.	
2. Show that substances can be classified on the basis of combustibility.	Combustibility of substances such as nails, paper, wood blocks, carpeting (5 cm x 5 cm), cloth, salt, and sugar can be tested. One activity could involve the use of tongs, an asbestos pad, and a bunsen burner to heat ma-	ISIS - Fire, Activity 3. Everyday Problems in Science. Nuffield Secondary Science: Using Materials.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - classifying - observing	terials other than salt or sugar. (The room should be well ventilated and students instructed to avoid fumes.) Materials may be labelled as easily ignited, continues burning, stops burning, or resists burning. Ask students to classify a list of materials, using their classification system.	
3. State the three factors necessary for a fire to occur: a) a combustible material (fuel);		ISIS - Fire, Activity 4. Everyday Problems in Science.
b) enough heat to bring a fuel to its ignition point;	A good conductor can be used to decrease the amount of burning in a candle flame.  	

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
c) the presence of oxygen. Process involved: - inferring	Oxygen can be produced from H_2O_2 (3%) and MnO_2 by the following procedure. First, a baby food jar is filled with H_2O_2, covered with a lid (which should be tightened), and inverted into a pan containing 3 cm of water. The lid of the jar is removed, keeping the neck underwater. A plastic straw is then dipped in MnO_2, until it contains about 2cm of MnO_2. This straw containing the MnO_2 is carefully placed under the neck of the jar, and the MnO_2 gently blown into the H_2O_2 solution. The collected gas can be tested with glowing charcoal and then with limewater. CAUTION must be used in gathering oxygen.	
4. State that the combinations among atoms are changed in the chemical reaction of burning and that atoms are conserved. (Balance simple equations of burning.)		ISIS - Fire, Activity 5. Modern Physical Science.
5. Describe three general ways to control fire. Processes involved: - controlling and manipulating variables. - inferring	Students can produce CO_2 (marble chips and HCl), and collect it by water displacement. They can pour the collected gas over a burning candle located in a beaker (using a control). The activity can be discussed, and its principle applied to smothering a paper fire in a waste paper basket.	ISIS - Fire, Activity 6. Nuffield Secondary Science: Using Materials. Everyday Problems in Science. Pamphlet (Office of the Fire Commissioner): "This is Your New ABCD's of Portable Fire Extinguishers." Film: "Your ABCD's of Port-

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
		able Fire Extinguishers." ISIS - Fire, Activity 7. Pamphlet (Office of the Fire Commissioner): Fire, Exit, Fire Escape for Office Workers.
6. Describe the ways that fire can be the direct or indirect cause of injury and ways to reduce the possibility of injury or death in fires. Process involved: - interpreting data		
7. Describe the characteristics common to explosions; identify the factors that can increase the possibility of explosions occurring; and apply this information to examples. Processes involved: - observing - inferring	The activity illustrated below can be demonstrated. CAUTION: Since explosive substances are involved, teachers may wish to experiment with small quantities before performing the demonstration.  	ISIS - Fire, Activity 8. Physical Science: A Search for Understanding.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	OR Lycopodium powder can be blown into a flame to illustrate the effect of increasing surface area upon burning rate.	
8. a) Identify safe and unsafe procedures for storing and using flammable materials;		ISIS - Fire, Activities 9-10. Don't Lose Lives Saving Energy. Shell Helps Series - "The Fire Safety Book."
b) Apply safety procedures for developing escape routes in the home.	Students can plan safety routes within a home in case of fire.	Pamphlets (Office of the Fire Commissioner): In a Fire, Seconds Count; Fire Safety in the Home; Fire Prevention All Over Your Home; Mobile Home Fire Check; Babysitter's Handbook; Early Fire Detection in Residential Buildings; Apartment and Condominium Fire Safety; Fire Safety for You: A Guide for Handicapped People; The Old Lady; A Fire-Safe Holiday.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
9. Describe ways in which the rate of burning of flammable materials (clothes) can be retarded through the use of chemicals. Processes involved: - observing - inferring	The following apparatus is required for the suggested experiment: bunsen burner, tripod, gauze, metal dish (e.g., tin lid), fabric samples about 5 cm x 5 cm (e.g., wool, cotton, rayon, silk, terylene, nylon, and glass fibre as a sample of flame-proofed material). Flame-proofing solution can be made by dissolving 43.5 g of borax and 18.5 g of boric acid in 500 cm^3 of water. Students can treat the materials with flame-proofing solution, let them dry, and then try to burn them.	ISIS - Fire, Activity 16. Nuffield Secondary Science: Using Materials. Pamphlets (Office of the Fire Commissioner): Clothing Can Burn and Don't Let Your Family Burn. Pamphlets (Consumer and Corporate Affairs): Carelessness and Fabric Fires; Facts Relating to Textile Flammability; Hazardous Products Act (July 27, 1976). (This last pamphlet sets standards and conducts tests to insure that fabrics sold do not burn too fast.)

SCIENCE AND HUMANITY

Rationale:

This option unit attempts to develop in students a better understanding of the capacity and limitations of science in resolving environmental or other problems.

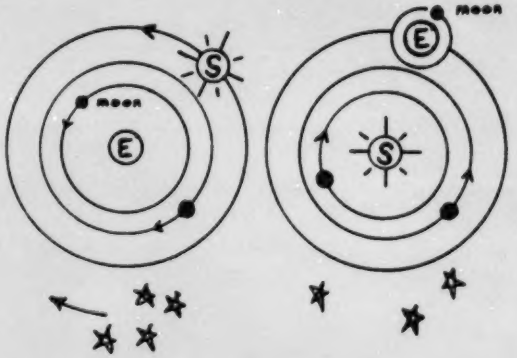
Basic Reference:

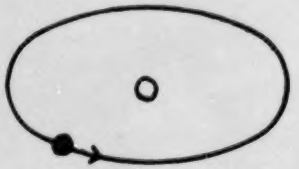
1. Abraham, Norman, et al. Interaction of Matter and Energy: Inquiry in Physical Science (IME), 3rd ed., Chicago: Rand McNally, 1979.

Supplementary References:

1. Andrews, William, et al. Physical Science: An Introductory Study. Scarborough, Ont.: Prentice-Hall of Canada, 1978.
2. Fisher, R.B. Science, Man and Society. Toronto: W.B. Sanders Co., 1975.
3. 100 Ways to Save Energy in the Home. Energy, Mines and Resources, Ottawa, 1980.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to: 1. Distinguish between observation (direct and indirect), inference, and models (theories); describe how theories and thus "truth" may change in science. Processes involved: - observing - gathering and interpreting data	Provide students with black boxes containing marbles and with probes or knitting needles for making observations (indirect) about the structure of the material in the box. Models of what is in the box should be built from the evidence. This can be related to how theories change in science on the basis of new evidence, as, for example, the earth-centred model of the universe changed to the sun-centred model:	IME - Section 14. Physical Science: An Introductory Study - Unit 1.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	Earth-Centred . The earth does not move. . The sun, moon and planets move around the earth in different patterns. . The fixed stars orbit the earth but, moving alike, rise and set on the horizon. Sun-Centred . The planets move differently because they orbit the sun at different speeds. . The earth turns daily, causing the stars to appear to rise or set.  Observations of the speed of orbiting bodies (related to their position) suggested changes in theory--an elliptical	

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
	orbit proved to be a better explanation than a circular orbit. (In circular orbit, a body has the same speed all the way around; in elliptical orbit, a body nearer to the central body moves faster.)  (elliptical)	
2. Describe how science and technology may affect the job market. Process involved: - interpreting data	The following data can be used to determine how science-technology has affected the job market and what kind of jobs may appear, increase, or disappear in the future. From the following charts, have students relate job growth to the effects of science-technology.	See guidance counsellors for additional information.

WHAT SCIENCE HELPED	RESULTING TECHNOLOGY	JOB CREATED	GROWTH %
Winning of World War II by electronic, missile and nuclear warfare	computers and transistors	computer service	86
Providing jobs for World War II veterans by increasing U.S. industrial production	factory-waste management	waste-water operator	61
Saving of energy and fossil fuels in the heating of homes, factories and offices	insulation of construction	asbestos installer	67
Displacement of coal furnaces and steam boilers by engines run by petroleum products	automobile production and highway construction	state police officer	68

WHAT SCIENCE HELPED	RESULTING TECHNOLOGY	JOB DECREASED	DECREASE %
Automatic machinery and increased population	assembly-line production of cheap shoes	shoe repairer	11
Automatic machinery and electronic communication	automatic printing process; new news media (radio and TV)	printer	6
Prefabrication of building construction units	plasterboard manufacture	plasterer and lather	2
Generation of electric power	mass production of household appliances	private household worker	27

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES

JOB FIELD	FAST-GROWING JOB IN FIELD	INCREASE TO 1985 (in %)	FAST-DISAPPEARING JOB IN FIELD	TO 1985 (in %)
Mechanics and repairers	computer service	86	shoe repairer	11
Industrial production	waste-water operator	61	printer	6
Construction	asbestos installer	67	plasterer and lather	2
Personal service occupations	state police officer	68	private household worker	27

3. Describe the trade-offs involved in the application of scientific/technological research to societal problems.	Possible solutions to societal problems can be examined; consider, for example, the extent to which new insulators resolve the problems of energy needs for home heating. Discuss the trade-offs (e.g., energy used to produce insulating materials can cause environmental problems).	IME - Section 14. 100 Ways to Save Energy and Money in the Home.

BUYING AND SELLING

Rationale:

Advertising, the art of persuasion, is perhaps the most widely used art form in consumer countries. This option unit examines the techniques used in successful advertising so students may understand why ads appear as they do, and how to evaluate the product information given in the ads. It also provides the opportunity for students to use some of the psychological techniques and scientific procedures of advertisers to write their own ads.

Basic Reference:

1. Buying and Selling. ISIS. Lexington, Mass.: Ginn, 1976.

Supplementary References:

1. Health and Welfare Canada. Health Protection and Food Laws Resource List for Educators. Available from Health and Welfare Canada, Federal Building, 310-269 Main Street, Winnipeg, Manitoba, R3C 1B2.

2. Manitoba Department of Health and Social Development.
   Buying Guide: Floor Covering,
   Buying Guide: Carpet,
   Buying Guide: Upholstery Fabric,
   Buying Guide: Drapery.

3. Canadian Association of Broadcasters. Broadcast Code for Advertising to Children. Single copies available at no cost from the Canadian Association of Broadcasters, P.O. Box 627, Station B, Ottawa, Ontario, K1P 5S2.

4. Province of Manitoba Consumer's Bureau. Wheels and Deals. This and other relevant pamphlets can be obtained from the Manitoba Consumer's Bureau, 307 Kennedy Street, Winnipeg, Manitoba, R3C 0V8.

NOTE: In rural areas, all or most of the Supplementary References 1-4 can be obtained from the local extension of the Manitoba Department of Agriculture.

Supplementary Reading: Various consumer information magazines such as Canadian Consumer, Consumer Reports, Consumer's Digest, Popular Science (new car evaluations).

Supplementary Viewing: "Marketplace," (television show).

Audio-Visual Resources:

1. The Chemical Feast.

2. It's New, It's Neat, It's Obsolete.

3. Consumer Game.

All films listed above are available from the Department of Education Film Library.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
The student should be able to:		
1. Identify the target audience of an ad and describe how the ad uses color, lighting, camera angle, models, props, and background to appeal to that group. Process involved: - observing	Students can view a variety of ads, read descriptive information and answer questions about them.	ISIS - Buying and Selling, Activity 2.
2. Describe how music, voices, and sound effects are used in ads to appeal to the emotions of the listener. Process involved: - observing	Students can listen to a variety of sound tracks for ads and answer questions regarding the effectiveness of them.	ISIS - Buying and Selling, Activity 3.
3. Describe at least three different sources of information about consumer products (labels, ads, consumer magazines, test reports, etc.). Processes involved: - observing	Students can read about sources of consumer information and examine these sources to determine the type of information provided. Note: In farming areas you might want to have on hand a sample of the farm equipment evaluation reports produced by the Prairie Agricultural Machinery Institute, Portage la Prairie, Manitoba.	ISIS - Buying and Selling, Activity 4.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
- collecting and interpreting data		
4. Describe how the shape of a package can affect a person's estimate of the weight or volume of the contents. Processes involved: - observing - collecting and interpreting data	Students can estimate the volume of various containers and then measure the actual volumes they can hold. They can also estimate the weights of various objects and then determine their actual weights.	ISIS - Buying and Selling, Activity 5.
5. Compare different brands of food by using product labels. Process involved: - observing	Students can read about label requirements, observe food labels, and answer questions about the information provided.	ISIS - Buying and Selling, Activity 6. Note: Canadian regulations are different from American.
6. Calculate unit prices of consumer products.	Students can calculate unit prices for a variety of consumer products.	ISIS - Buying and Selling, Activity 7.
7. Describe how computers are used for handling charge accounts and how to have computer errors rectified.	Students can read descriptive information and answer questions relevant to this objective. As a supplementary activity, students can compose their own letters in response to a computer error in billing.	ISIS - Buying and Selling, Activity 8.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
8. Analyze an ad to identify factual statements, opinions, misleading statements, and catchy but irrelevant information.	Students can study various ads and answer questions based on their analysis of the ads. Questions should be concerned with the amount of useful information presented.	ISIS - Buying and Selling, Activity 9.
9. Describe how various brands/ forms of the same type of food can vary. Processes involved: - observing - classifying - quantifying - controlling variables - collecting and interpreting data	Students, with rather specific guidance, can design and conduct taste tests of various brands of foods.	ISIS - Buying and Selling, Activity 10.
10. Describe how techniques such as repetition, association, and catchy words are used in advertising. Processes involved: - observing - collecting data - interpreting data	Students can study printed and auditory advertisements and answer questions about the techniques used. They can also design and create their own ads.	ISIS - Buying and Selling, Activity 11.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
11. Develop and administer a survey to identify individuals' brand preferences or the effectiveness of advertisements. Processes involved: - making operational definitions - collecting and interpreting data - controlling variables	Students can read about the design of surveys and then develop and conduct a survey.	ISIS - Buying and Selling, Activity 13.
12. Identify eight categories of psychological needs and describe how these are appealed to in ads. Processes involved: - making operational definitions - collecting and interpreting data - controlling variables	Students can read about the categories of needs and then analyze ads to determine which needs are appealed to.	ISIS - Buying and Selling, Activity 14.
13. Describe and use a technique for determining psychological preferences.	Students can design and administer a preference test.	ISIS - Buying and Selling, Activity 14.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Processes involved: - controlling variables - collecting and interpreting data		
14. Describe how logical understanding of volume varies among different persons. Processes involved: - observing - collecting and interpreting data		ISIS - Buying and Selling, Activity 15.
15. Describe the effectiveness of slogans and jingles in ads. Process involved: - collecting and interpreting data	Students can conduct a survey to assess how well people remember advertising slogans and jingles.	ISIS - Buying and Selling, Activity 17.
16. Categorize ads in terms of the human needs, wants, or wishes they appeal to: sex appeal, success, novelty, conformity, independence, knowledge, public service, self love, and utility.	Students can study examples of ads that appeal to various needs, wants, or wishes and then collect and classify a variety of ads.	ISIS - Buying and Selling, Activity 18.

OBJECTIVES	SUGGESTED ACTIVITIES	REFERENCES
Process involved: - classifying		

appendices

APPENDIX A: PROCESS SKILLS

An important goal of science instruction in Manitoba schools is to encourage students to become increasingly active investigators of science. Instruction in the processes of science should begin in elementary grades and continue through the junior high - middle years. As a result, students should be equipped for more complex learning in science as well as other areas of investigation.

The objectives of this program allow students to develop and use process skills that are essential to science education. Some methods of developing these skills are presented below.

Process	Description of Behavior	Sample Activities
Observing	Competence in using the senses and mechanisms for extending these senses in the collection of data from physical phenomena.	Have students render both oral and written descriptions of phenomena; for example, the relative temperatures of water and the air above the water could be described.
Classifying	Competence in grouping articles, objects and ideas on the basis of some observable physical and chemical attributes.	Have students classify objects according to texture, color, and special characteristics. Single-stage classifications are followed by two-stage and multi-stage classifications. Information retrieval is a necessary extension of classification.
Quantifying	Competence in using numbers and in measuring length, weight, area, volume, and rate of change of physical phenomena.	Have students distinguish objects by using such terms as heavier and lighter; identify relative weight by lifting; use a balance to distinguish heavier from lighter objects; use standard units of weight; explain effects of gravitation and inertia; measure the weight of various objects; describe differences in weight; identify, state and demonstrate differences in perception of weight.

Process	Description of Behavior	Sample Activities
Formulating hypotheses	Competence in making an hypothesis (if...then statement) regarding the causes of a phenomenon or the relationship between two variables.	Have students make hypotheses similar to those that follow. - If the air pressure inside a tube is less than the air pressure outside a tube, then water will rise in the tube. - If a ball is dropped, then its speed will increase as it approaches the floor.
Making operational definitions	Competence in stating the operation to be performed and the observations to be made in applying a definition to an experiment.	Have students make definitions similar to those that follow. - Cold means 15°C for this experiment. - Little friction means that not more than an additional 10% of force over and above the weight of the object is required to move the object across a surface.
Controlling and manipulating variables	Competence in making decisions concerning the control and manipulation of objects or conditions in an experiment, and in arranging conditions.	Have students consider two pendula swinging at different rates. Variables to control might include the weights (size, shape and mass), the string (length and thickness), and the length of the swing. Or, have them conduct an experiment to determine whether metals expand when heated. Variables to control might include the kind of metal used and the temperature attained.
Interpreting data	Competence in getting the most out	Have students interpret observations

Process	Description of Behavior	Sample Activities
	of data without oversimplifying, in drawing conclusions supported by the data, and in considering alternative explanations on the basis of observed or supplied data.	presented verbally, in graphs, histograms, and tables.
Formulating models	Competence in building both physical and mental models to account for phenomena.	Have students formulate models by drawing pictures of the moon's surface or diagrams of the life cycle of an insect, or by creating physical models of a chromosome or mental model - ideas of an atom. Then have them communicate the results which involves the synthesis and organization of data.
Communicating	Competence in describing an experiment so that an individual who has not seen it can carry it out.	Have students identify and name objects, then graph and describe measured changes. For example, students could first identify and name events that can be quantified, such as five bounces of a ball, and then describe changes in the height of the bounces, the time between them, and other properties; they could make a prediction on the basis of recorded measurements, and then make a graph to show the prediction.
Inferring	Competence in drawing more than one inference or conclusion from a set of data, in demonstrating that an inference can be tested by	Have students use the concept of evaporation to explain how water is lost by plants. They could be asked to demonstrate a way to measure the water

Process	Description of Behavior	Sample Activities
	applying known tests to the properties of objects, and in distinguishing between observations and inferences.	used by a plant, to infer and to demonstrate that water drawn through plants is transferred to the atmosphere, and to show that an inference may be tested by additional observations.
Predicting	Competence in conducting experiments to test predictions of relationships between two measurable quantities.	Have students analyze a graph to determine the pattern relationships (increasing, decreasing, stable). They could, for example, use a graph to predict water loss from plants; or they could make predictions from a series of observations by means of graphs, and conduct an experiment to test predictions.
Experimenting	Competence in planning, conducting and communicating an experiment in which the problem is clarified, hypotheses are stated, observations are made, and data is interpreted. This process depends upon the use of all the other processes.	Have students develop experiments to answer questions similar to those that follow. - How do mealworms react to light? - How many nails can a magnet lift? - What happens to salt when it is placed in water? Does more salt dissolve in water at 35°C than at 20°C?

APPENDIX B: ANNOTATED BIBLIOGRAPHY

Science 100

1) Haber-Schaim, Uri, J.B. Cross, G.L. Abegg, J.H. Dodge, and J.A. Walter. Introductory Physical Science. 3rd ed. Englewood Cliffs, N.J.: Prentice-Hall, 1977; and 4th ed., 1982.

   This text relates the nature of matter (physical and chemical properties) to the atomic model of matter. Lab activities focus on the development of concepts, laboratory skills, and scientific processes. The labs generally use readily available equipment. Many questions that emphasize quantitative aspects of science are available within the text. The reading level is satisfactory for the average Grade 10 student. A teacher's guide is available.

2) Andrews, William A., T.J.E. Wolfe, and J.F. Eix. Physical Science: An Introductory Study. Scarborough, Ont.: Prentice-Hall of Canada, 1978.

   Topics include the nature of matter, the particle theory and chemical properties of matter, the nature of air and its components, forces and motion, and light and heat energy. Lab activities emphasize concepts, laboratory skills, and scienctific processes and generally use readily available equipment. There is some emphasis on practical applications. The reading level is satisfactory for the average Grade 10 student. A teacher's guide is available.

3) Burkman, Ernest, et al. Individualized Science Instructional System (ISIS). Lexington, Mass.: Ginn.

   * Cells and Cancer, 1977, 76 pp.
   * Let's Eat, 1977, 76 pp.
   * Packaging Passengers, 1976, 76 pp.
   Fossil Fuels, 1980, 76 pp.

   The modules are individualized to allow students to work at differing rates and at differing levels of difficulty. A lock-step, full-class or small-group approach can also be used. Each unit contains core, excursion, and advanced activities. Core activities develop concepts and skills at a fundamental level. Excursion activities extend these concepts into related topics. Advanced activities develop more rigorous theoretical concepts. The units emphasize the development of scientific concepts and processes within a framework of both scientific inquiry and practical applications. Both hands-on activities and questions are used to develop the concepts. Required laboratory equipment is generally readily available and inexpensive. The reading level is satisfactory for the average Grade 10 student. Some units provide statistics only for the United States. Where the use of this data base presents a problem, as in the module Fossil Fuels, Canadian data will be made available by the Department of

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* Ancilliary materials such as cassette tapes or diagnosis games are required. Refer to publisher's catalogue or annotated teacher's edition for details.

Education. Some units require audio cassette tapes in order for the concepts to be taught successfully. Additional support materials are available such as resource units, tests, annotated teacher's editions for each unit, and a booklet entitled Managing ISIS. The last two are particularly valuable because of the information they contain on implementing materials.

Science 101

1) Abraham, Norman, et al. Interaction of Matter and Energy: Inquiry in Physical Science. 3rd ed. Chicago: Rand McNally, 1979.

This text discusses chemical reactions, the periodic table and atomic theory. Additional topics include motion and energy, phases of matter, heat and light, and the role of science in society. The text uses an inquiry approach. A teacher's guide is available.

2) Burkman, Ernest, et al. Individualized Science Instructional System (ISIS). Lexington, Mass.: Ginn.

* Actions and Reactions, 1978, 84 pp.
* Packaging Passengers, 1976, 76 pp.
Fire, 1978, 76 pp.
Fossil Fuels, 1980, 76 pp.
Household Energy, 1976, 76 pp.
Know Your Car, 1980, 76 pp.
* Cells and Cancer, 1977, 76 pp.
Ways We Learn, 1976, 76 pp.
* Let's Eat, 1977, 76 pp.
Food and Microorganisms, 1976, 76 pp.
* Buying and Selling, 1976, 76 pp.

The modules are individualized to allow students to work at differing rates and at differing levels of difficulty. A lock-step, full-class or small-group approach can also be used. Each unit contains core, excursion, and advanced activities. Core activities develop concepts and skills at the fundamental level. Excursion activities extend these concepts into related topics. Advanced activities develop more rigorous theoretical concepts. The units emphasize the development of scientific concepts and processes within a framework of both scientific inquiry and practical applications. Both hands-on activities and questions are used to develop the concepts. Required laboratory equipment is generally readily available and inexpensive. The reading level is satisfactory for the average Grade 10 student. Some units provide statistics only for the United States. Where the use of this data base becomes a problem, as in the module Fossil Fuels, Canadian data will be made available from the Department of Education. Some units require audio cassette tapes for the concepts to be taught successfully. Additional support materials are available such as resource units, tests, annotated teacher's editions for each unit, and a booklet entitled Managing ISIS. The last two are particularly useful because of the information they contain on implementing materials.

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